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A DESCRIPTION
OF
MINERALS OF COMMERCIAL VALUE

BARRINGER

UNIVERSITY OF CALIFORNIA.

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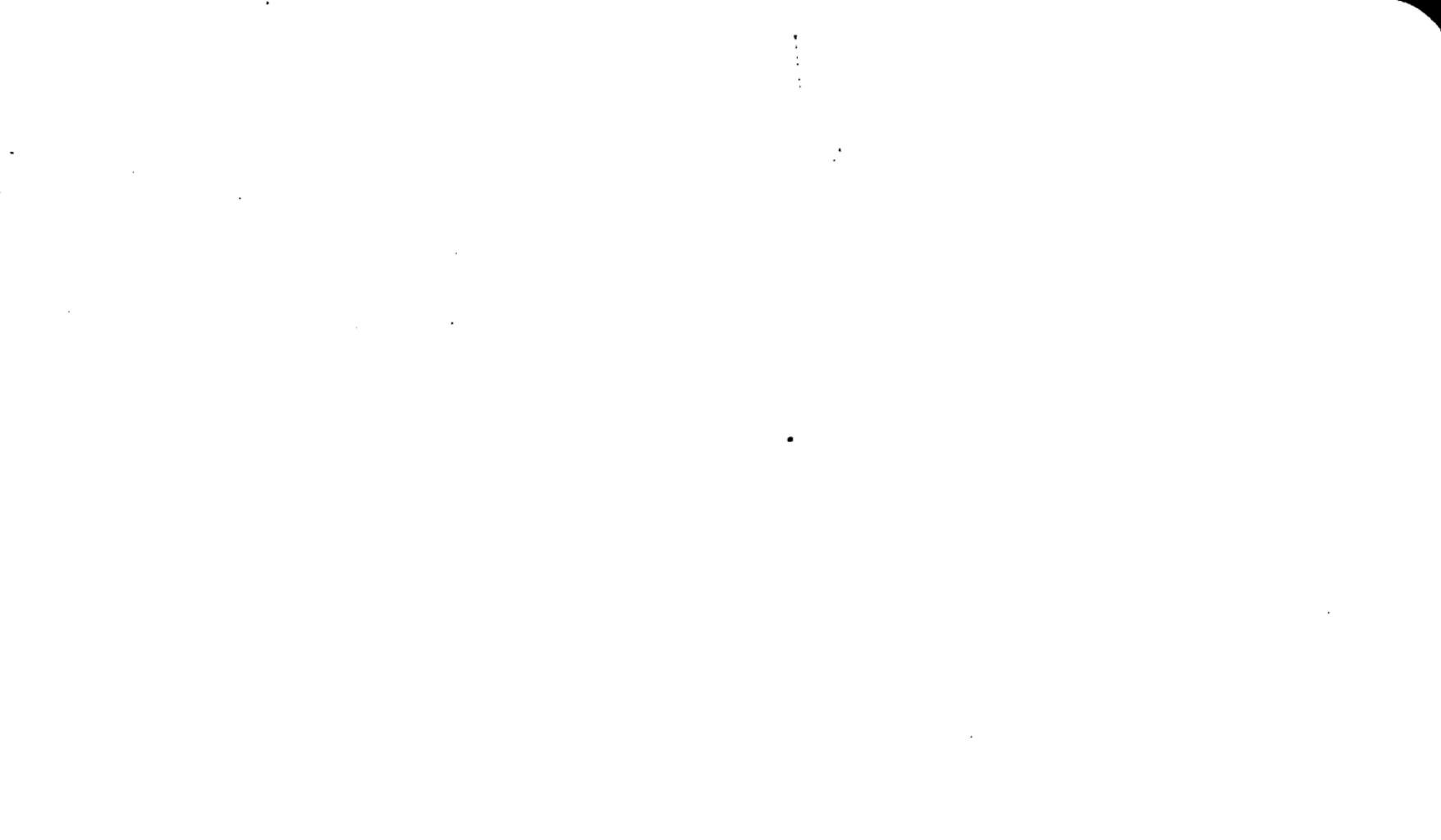
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BY THE SAME AUTHOR.

THE LAW OF MINES AND MINING
IN THE
UNITED STATES.

BY
DANIEL MOREAUX BARRINGER AND JOHN STOKES ADAMS.

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A DESCRIPTION
OF
MINERALS OF COMMERCIAL VALUE.

*A Practical Reference-book for the Miner, Prospector, and Business Man, or
any Person who may be interested in the Extraction or Treatment
of the Various Metallic or Non-metallic Minerals, and for
Students either in Field-work or in the Laboratory.*

BY
D. M. BARRINGER, A.M., LL.B.,
One of the Authors of "The Law of Mines and Mining in the United States."

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FIRST THOUSAND.

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PREFACE.

IN the preparation of this little book the original intention of the author was to give in as simple and concise a form as possible a description of the nature of only the more important of those mineral substances, more frequently referred to as ores or compounds, *which possess commercial value*, indicating at the same time the means by which they could be identified, and referring very briefly to some of the principal economic uses to which they are put. Upon reflection, however, it seemed advisable not to confine the work too strictly within this limitation, but to insert also a description of a few other minerals which are very frequently met with as common veinstones (i.e., gangue of the metallic ores) or as rock constituents, although they may possess in themselves little or no commercial worth. Outside of this he has not attempted to go, for by so doing he would be defeating the object he has had in mind, namely, to carefully exclude all minerals which do not fall under either of the above classifications —by far the greater number—and to thus confine himself to a brief *working description of those which, for the reasons given, are directly or indirectly useful.*

The work is intended merely as a book of reference to be used by the practical miner or man of business, for whom especially it is intended, as well as by the geologist, metallurgist, or mineralogist, in so far as it may serve their purposes. If the desired mineral be not enumerated in the following pages, or the information concerning it be not sufficiently complete, reference

must be had to some of the many excellent and much more comprehensive works upon mineralogy by such well-known authors as Dana, Brush, Erni, von Kobell, Rutley, etc., from which this little volume has been very largely compiled.*

In the arrangement of the material—that is, the grouping of the various ores or compounds under the element for the extraction of which they are chiefly mined—the author has adopted the simplest and most logical form which has occurred to him, and he hopes that it will meet with the approbation of the majority of those who may have occasion to refer to the following pages.

D. M. BARRINGER.

BULLITT BUILDING, PHILADELPHIA, June, 1897.

* For fuller information concerning any mineral, its economic uses or mode of occurrence, the two following most excellent and modern works should be consulted: Dana's *System of Mineralogy* (1897), and Rothwell's *Mineral Industry* (in five volumes, 1892-1895). The latter work contains much very useful information concerning the occurrence, production, and uses of the various minerals of economic importance. The author wishes to acknowledge his indebtedness to the authors of the above books, from which a very considerable portion of the information herein contained has been derived. See also the *Geological Preface to The Law of Mines and Mining in the United States* (Barringer and Adams, 1897, published by Little, Brown & Co. of Boston), by the author of this work, which contains a detailed description of the various kinds of ore deposits and their mode of occurrence in nature.



A DESCRIPTION
OF
MINERALS OF COMMERCIAL VALUE.

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PART

I.—SYMBOLS AND ATOMIC WEIGHTS

NAME.	SYMBOL.	AT. WT. (approx.).	NAME.	SYMBOL.	AT. WT. (approx.).
Aluminum.....	Al	27	Didymium.....	Di	142.5
Antimony (<i>Stibium</i>).....	Sb	119.5	Erbium.....	Eb	166
Argon.....	Ar	19.8 (?)	Fluorine.....	F	19
Arsenic.....	As	75	Gallium.....	Ga	70
Barium.....	Ba	137	Germanium.....	Ge	73.3
Beryllium.....	Be	9	Gold (<i>Aurum</i>).....	Au	197
Bismuth.....	Bi	207.5	Hydrogen.....	H	1
Boron.....	B	11	Indium.....	In	113.5
Bromine.....	Br	80	Iodine.....	I	126.5
Cadmium.....	Cd	112	Iridium.....	Ir	192.5
Cæsium.....	Cs	132.7	Iron (<i>Ferrum</i>).....	Fe	56
Calcium.....	Ca	40	Lanthanum.....	La	138.5
Carbon.....	C	12	Lead (<i>Plumbum</i>).....	Pb	206.5
Cerium.....	Ce	140	Lithium.....	Li	7
Chlorine.....	Cl	35.5	Magnesium.....	Mg	24
Chromium.....	Cr	52	Manganese.....	Mn	55
Cobalt.....	Co	58.7	Mercury (<i>Hydrargyrum</i>)	Hg	200
Copper (<i>Cuprum</i>).....	Cu	63			

II.—SYSTEMS OF CRYSTALLIZATION.

1. *Isometric* (e.g., cube and octahedron).—Three axes rectangular in intersections and equal.
2. *Tetragonal* (e.g., right prism with square base).—Three axes rectangular in intersections—two lateral axes equal and unequal to the vertical, which may be longer or shorter.
3. *Hexagonal* (e.g., rhombohedron and hexagonal prism).—The vertical axis, which may be longer or shorter than the lateral, is at right angles to them; the lateral, which are equal, are three in number and intersect at angles of 60°.

I.

OF THE ELEMENTS.

NAME.	SYMBOL.	AT. WT. (approx.).	NAME.	SYMBOL.	AT. WT. (approx.).
Molybdenum.....	Mo	96	Silver (<i>Argentum</i>).....	Ag	107.5
Nickel.....	Ni	58.5	Sodium (<i>Natrium</i>).....	Na	23
Niobium.....	Nb	93.7	Strontium.....	Sr	87.5
Nitrogen.....	N	14	Sulphur.....	S	32
Osmium.....	Os	191	Tantalum.....	Ta	182
Oxygen.....	O	16	Tellurium.....	Te	127.6
Palladium.....	Pd	106.3	Thallium.....	Tl	203.6
Phosphorus.....	P	31	Thorium.....	Th	232
Platinum.....	Pt	194.5	Tin (<i>Stannum</i>).....	Sn	117.5
Potassium (<i>Kalium</i>).....	K	39	Titanium.....	Ti	48
Rhodium.....	Rh	104	Tungsten (<i>Wolfraam</i>).....	W	183.5
Rubidium.....	Rb	85.2	Uranium.....	Ur	240
Ruthenium.....	Ru	101.5	Vanadium.....	V	51
Samarium.....	Sa	149.6	Ytterbium.....	Yb	172.6
Scandium.....	Sc	44	Yttrium.....	Yt	89.5
Selenium.....	Se	79	Zinc.....	Zn	65
Silicon.....	Si	28	Zirconium.....	Zr	90.5

4. *Orthorhombic* (e.g., right prism with rectangular or rhombic base).—The three axes rectangular in intersections and unequal.

5. *Monoclinic* (e.g., right rhomboidal and oblique rhombic prisms).—Only one oblique inclination (one lateral axis inclined to the vertical) out of the three made by the intersecting axes, two being rectangular; the three axes are unequal.

6. *Triclinic* (e.g., oblique asymmetric rhomboidal prisms).—All three axes unequal and their intersections are all oblique.

III.—SCALE OF HARDNESS.

1. Talc.

2. Gypsum, Rock Salt.

3. Calcite.

4. Fluorite.

5. Apatite.

6. Feldspar.

7. Quartz.

8. Topaz.

9. Corundum, Sapphire.

10. Diamond.

IV.—SCALE OF FUSIBILITY.

1. Stibnite. **2. Natrolite.** **3. Alumina-iron Garnet.** **4. Actinolite.** **5. Orthoclase.** **6. Bronzite.**

V.—CHIEF DIVISIONS.

1.

ALUMINUM AND ITS COMPOUNDS.

Heated on charcoal or in forceps in O. F. with cobalt nitrate and reheated gives a blue color. A blue infusible mass only indicates alumina. (See Heating with Cobalt Nitrate in Appendix.)

2.

ANTIMONY AND ITS COMPOUNDS.

When strongly heated in closed tube yields a sublimate near assay which is black when hot and brown-red when cold. Characteristic dense white fumes. On charcoal white sublimate near assay, bluish distant from assay; crystals in coating far from assay are octahedrons; those near assay needlelike (use lens). Sublimate less volatile than that of arsenious acid. H₂S passed through acidified antimonial solution gives orange precipitate. Dissolved in aqua regia or hot H₂SO₄. When native takes fire and continues to burn without further heating, and becomes covered with white needles of antimony oxide.

3.

ARSENIC AND ITS COMPOUNDS.

Heated on charcoal volatilizes with white incrustation, which is deposited far from assay, and which is easily driven off by the flame. When abundant easily recognized by garlic odor of the fumes. In closed tube gives brilliant black sublimate near assay with alliaceous fumes. When flame is applied to this sublimate it volatilizes, and the characteristic brilliant but minute octahedral crystals of oxide of arsenic are deposited further up the tube.

4.

BISMUTH AND ITS COMPOUNDS.

Its presence is detected by characteristic lemon or orange sublimate, which it and its compounds give when treated alone or with soda on charcoal before blowpipe. With sulphur and potassium iodide gives a scarlet coating far from the assay. Readily dissolved by nitric acid, which solution when concentrated gives white precipitate when poured into excess of water. The ores are rare.

5.

CALCIUM AND ITS COMPOUNDS.

The presence of calcium may be often detected by the fine orange-red color which its compounds impart to blowpipe flame. Best, however, to test for it in the liquid way. Carbonate of ammonium produces in neutral calcium solutions a white precipitate (CaCO_3) which is soluble in acids with effervescence (CO_2).

6.

CHLORINE.

This element, though not occurring in a free state in nature, is largely used and frequently met with through the many compounds which it forms, such as chloride of ammonium, copper, mercury, potassium, sodium, tin, silver, etc., which see.

Chlorides when heated with strong sulphuric acid, save those of mercury, silver, and tin, evolve hydrochloric-acid gas, known by its pungent smell and acid reaction. When heated with peroxide of manganese and sulphuric acid chlorine gas is given off, recognizable by its irritant odor, green color, power of bleaching litmus, etc., and by the purple stain it produces on a piece of starch-paper moistened with iodide of potassium. When fused with a little carbonate of sodium and red chromate of potassium they furnish a mass which, when warmed with strong sulphuric acid, gives off deep red vapors of chromic chloride, CrOCl_3 , decomposable by water to furnish an orange solution of mixed chromic and hydrochloric acids, becoming, not colorless, but only yellow, when rendered ammoniacal. (Odling.) Fused in a bead of microcosmic salt saturated with CuO imparts an azure-blue color to flame.

7.

CHROMIUM AND ITS COMPOUNDS.

Exists chiefly in two native compounds, viz., crocoite (Siberia) or *chromate of lead*, and *chromite* or oxide of chromium and iron. It is, when reduced to metallic state, a whitish, brittle, and very infusible metal. Chief source is chromite, which is slightly magnetic. Fuses slightly, is soluble, and imparts a beautiful emerald-green color to beads of borax and salt of phosphorus when cold.

8.

COALS.

These may be generally easily recognized by their physical characters, which are too well known to require description. "It passes from forms which still retain the original structure of the wood (*peat, lignite*), and through those with less of volatile or bituminous matter to anthracite, and further to kinds which approach graphite" (Dana). Each species gives variable analyses according to amount of impurities present, etc., etc.

NOTE.—A *coking coal* is a bituminous coal which softens or becomes pasty or semi-viscid in the fire. This is attended with escape of bubbles of gas. The volatile products resulting from the decomposition of the softened mass being driven off, a more or less coherent, grayish-black, cellular, or fritted mass is left, which is *coke*, or the part not volatile, and which varies from 50 to 85 per cent. A *non-coking, free-burning* coal may be like the former in all external characteristics, and even in percentage of volatile matter and in general composition, but it burns freely without softening or any appearance of incipient fusion. The coke resulting from this is not a proper coke, being often in a powder or in the form of the original coal. (Dana.)

9.

COBALT AND ITS COMPOUNDS.

Easily recognized by the characteristic deep sapphire-blue bead in both flames with borax or salt of phosphorus. The sulphurets should be roasted on charcoal before testing with borax, as in other metallic species. Dissolves in nitric acid. The insolubility of the black sulphides of nickel and cobalt in dilute HCl suffices to separate these metals from the remaining members of the group. If ferrocyanide of potassium be added to solution, first made freely ammoniacal, a green precipitate is produced.

If ferrocyanide be added, the precipitate is brown-red. (Do not confound with similar precipitate of copper.) Sometimes associated with oxides of manganese. (Missouri and South Carolina.) Largely associated with arsenic, but the blue color of bead suffices to readily distinguish them from arsenopyrite.

10.

COPPER AND ITS COMPOUNDS.

Borax bead in O. F. is green when hot, and greenish-blue when cold ; in R. F. colorless if saturation be weak, but red with strong saturation when hot ; metallic copper and copper-red when cold. On charcoal with soda a copper-colored globule is obtained. When combined with the oxides, tin and borax should be used. When ammonia in excess is added to nitric acid solution, the liquid is colored blue ; metallic copper is deposited on iron wire or a nail immersed in this. Specimens should be roasted before making B. B. test with borax. For traces of copper place drop of suspected solution on platinum foil. Place in this a piece of zinc ; a film of copper will be deposited on the platinum foil at point of contact. Copper compounds moistened with a drop of HCl and ignited B. B. color the flame azure-blue.

11.

GOLD AND ITS COMPOUNDS.

Gold may be generally recognized by its physical characters—color, lustre, malleability, and specific gravity. When a gold compound is heated on a carbonized match or charcoal in R. F., a yellow malleable bead is obtained which dissolves in aqua regia. If this solution be dropped on to a filter-paper, and one drop of stannous chloride be added, a purple-red color is obtained. Gold can be readily detected in its solutions, inasmuch as it is obtained in a metallic state by reducing agents. The well-washed precipitate being dissolved and tested with stannous chloride, it is separated from the easily volatile metals by simply heating on charcoal in O. F. If associated with copper or silver, it must be fused with a large excess of pure metallic lead and subjected to cupellation. The copper is absorbed into the cupel with the lead, while the silver remains alloyed with the gold. If the globule is quite yellow, this is a proof that but little silver is present. It is then to be tested with salt of phosphorus to prove the presence of silver, which, after fusing on charcoal in O. F., will impart an opaline character to the cool bead. If it be more of a silver-white color, the amount of gold will be small ; and in order to prove its presence and approximate quantity, the globule must be digested with nitric acid by application of heat. The silver is thus dissolved, and the gold remains as a dark powder or spongy mass. If this powder or mass be washed and fused with borax on charcoal, it will yield a globule of metallic gold,

12.

HYDROCARBONS.

Compounds of carbon, hydrogen, and oxygen. These compounds are numerous, and form a great variety of economically important gaseous, liquid, and solid products, the composition and characters of the more prominent among which are stated under their proper heads. For sake of distinguishing between them the various coals are placed in a separate division, although they are also oxygenated hydrocarbons—one point of difference being that the substances here enumerated generally yield large quantities of paraffine, while this can be said of only few of the coals. While the latter chemically considered possess many characteristics in common with, they differ widely in physical and in other respects from, the varieties enumerated in the tables under this division.

13.

IRON AND ITS COMPOUNDS.

With borax in O. F. oxide of iron gives a dark brown-red glass, which becomes pale-yellowish or colorless on cooling ; in R. F. bottle-green on cooling. With tin the green color is hastened. Most of the compounds become magnetic when heated with soda on charcoal. Dissolve readily in HCl. Sulphide of ammonium gives to their solution a black precipitate, which is soluble in dilute HCl, distinguishing it from cobalt and nickel. Another excellent test is to add ferrocyanide of potassium to solution. A pale-blue precipitate indicates ferrous salts, and a dark-blue precipitate ferric salts, of iron. The presence of titanium may be detected by the fact that the borax or salt of phosphorus bead becomes violet-blue or reddish purple when the R. F. is directed upon it, especially if tin be added, and test made on charcoal. A better test is to add tin to concentrated HCl solution, and continue to boil. Set aside. If titanium is present, the solution becomes violet in color. The presence of chromium is also readily detected. (See Chromic Iron.)

14.

LEAD AND ITS COMPOUNDS.

They are easily fusible. With borax bead and with soda, and often alone, on charcoal, a malleable bead may be obtained. Readily recognized by characteristic lemon- or sulphur yellow coating near assay when cold ; red when hot. The outer coating is

faintly bluish white when cold. When S and KI are added there is a greenish-yellow coating far from assay. Sublimes readily. Volatile, tinging flames azure-blue. In nitric-acid solution of salts of lead sulphuric acid gives a white precipitate, which is nearly insoluble in water and dilute acids. Heated in open tube white smoke and a non-volatile fusible sublimate is deposited on under side of tube. Oxides, carbonates, etc., may be reduced to the metallic state by heating in R. F. with soda, and the characteristic coating will be produced on the coal. But sulphides, arsenides, etc., of lead must be treated in O. F. to produce the metal. Metallic lead obtained as above may be cupelled for silver on charcoal, or, better, on a bone-ash cupel. (See B. B. Silver Assay, Appendix.)

15.

MAGNESIUM AND ITS COMPOUNDS.

These afford a clear rose-red or pink color with cobalt nitrate after long heating. This distinguishes it from alumina. Distinguished from strontia and baryta by different flame-colors, and in the wet way by the fact that sulphuric acid gives no precipitate in dilute HCl solution. The fact that the precipitate from magnesia is soluble in water, while that from calcium is not, suffices to distinguish it from the latter, etc.

16.

MANGANESE AND ITS COMPOUNDS.

These are readily recognized by the characteristic *amethystine* color oxide of manganese imparts to beads of borax and salt of phosphorus in O. F.; colorless in R. F. With borax the color becomes violet, amethystine, or purple when hot; amethystine when cold. With salt of phosphorus, brown-violet when hot; pale red-violet when cold. Do not confuse with pale-violet color imparted to beads by presence of titanic acid, which only appears on heating in R. F. Too large a quantity renders bead opaque. With soda in O. F. on platinum wire or, preferably, platinum foil, the color is green or bluish green. Most varieties are soluble in hydrochloric acid with evolution of chlorine. The oxides are frequently associated with ores of iron, especially brown hematite (limonite), and less often with varieties of red hematite or magnetite

17.

MERCURY AND ITS COMPOUNDS.

Mercury and amalgams volatilize on charcoal, but give a sublimate of metallic mercury when heated in closed tube with or without soda; best with soda. The metal condenses above assay in globules on the tube. These may be brushed together with a feather, etc. When a gray sublimate is obtained without distinct metallic globules, the part of the tube coated with it is cut off and boiled in a test-tube with a little dilute HCl. By this treatment mercury collects in shining globules. In case mercury exists in so small a quantity that the sublimed metal is not perceptible, it may be detected by inserting a piece of gold-leaf held on end of iron wire into the tube just above assay. On heating the mercury is volatilized and unites with the gold, giving it a white color.

18.

MOLYBDENUM AND ITS COMPOUNDS.

With borax bead in O. F. colorless when hot; faint yellow when cold. With saturation the bead becomes in R. F. an opaque black or bluish to green enamel when cold.

19.

NICKEL AND ITS COMPOUNDS.

With borax the presence of nickel in O. F. renders bead, when hot, purplish, with tinge of violet; when cold, reddish sherry-brown. In R. F. the bead becomes purplish gray and turbid, with reduced nickel (use lens). If a fragment of nitre be added and the bead be again heated in O. F., a well-marked purple color is produced. Roast before making above tests. Arsenical compounds of nickel, cobalt, iron, and copper are treated with glass of borax (see Cobalt); when borax is no longer colored blue from cobalt, but acquires a brown color, which is violet when hot, the metallic globule is separated from the borax and treated with salt of phosphorus in O. F. If copper, as well as nickel, be present in the assay, the glass thus obtained will be green while both hot and cold. Treated with tin on charcoal it will become red and opaque on cooling. Black sulphides insoluble in dilute HCl. (See Cobalt.) Nitric solutions are apple-green. Excess of ammonia produces a violet-blue liquid, from which caustic potash slowly precipitates the green hydrate of nickel. Potash produces this precipitate from all ordinary nickel solutions.

20.

PHOSPHATE ROCK.

Mineral variety, apatite, which see. Common variety, often replacement of CaCO_3 by phosphate of lime; also includes fossil teeth, bones, etc. The substance examined for phosphorus is mixed with soda, as for sulphur (3 soda, 1 substance). A thin glass tube closed at one end has a piece of magnesium wire or ribbon, one-half inch long, dropped into it. Then the mixed soda and substance is added so as to cover the magnesium. Heat to fusion the contents of the tube until the glass is attacked. While still red plunge under water in a small vessel, and immediately apply the nose. The characteristic odor of hydrogen phosphide is evolved.

Precautions.—Heat to full fusion. Do not have too much water in vessel; see that end of tube is broken. The above test is not delicate enough for minute quantities, as in Bessemer-iron ores. In examining iron ores for phosphorus try to find small grains of apatite, and test as above. *Best test* is to add molybdate of ammonium to nitric-acid solution. An abundant bright yellow precipitate (phospho-molybdate of ammonium) indicates character of the specimen.

21.

SILVER AND ITS COMPOUNDS.

Silver compounds when fused with soda on charcoal yield a hard, white, malleable button, usually without any incrustation on the coal, but when treated for a long time with the reducing flame a slight dark-red coating is produced. When associated with volatile and easily oxidizable metals it may be separated by heating on charcoal in O. F., but if associated with large quantities of lead or bismuth it is best to subject it to cupellation. (See Appendix.) HCl gives in a solution of silver a white heavy precipitate of AgCl , which is insoluble in boiling nitric acid, but readily soluble in ammonia. The color of the precipitate changes to slate-purple by exposure to light. This is a distinguishing characteristic.

22.

SULPHUR AND SULPHIDES.

The following is usually sufficient to detect the presence of sulphur. Mix the substances suspected to contain sulphur with soda (3 soda, 1 substance), and heat on platinum wire or charcoal in R. F. The fused mass is then crushed on a clean piece of

silver (coin or plate), and a drop of water added. A yellowish stain on the silver indicates a trace of sulphur; larger quantities give a brown or a black stain. Sulphides such as pyrites, galena, etc., heated on charcoal give the odor of burning sulphur. Mixed with soda as above and heated in O. F. on platinum wire, the sulphides color the coin brown to black; but sulphates, gypsum, baryta, etc., so treated in O. F., do not color the coin; in R. F., however, the sulphate is changed to sulphide and colors the coin. Sulphides or substances containing sulphides in considerable quantities yield sulphur dioxide when heated in open tube. The sulphur dioxide may be recognized by its odor and by reddening, and sometimes bleaching blue litmus-paper inserted in end of tube. Usually soluble in nitro-hydrochloric or concentrated nitric acid. Some are extremely difficult to dissolve completely, owing to the deposition of sulphur, which fuses around the unaltered substance and prevents any action of the acid upon it, but these can usually be recognized by their volatility, etc. (mercury, arsenic, etc.). The higher sulphides give off sulphur when heated in closed tube. Free sulphur fuses and sublimes, and on charcoal burns with a blue flame, and affords odor of burning sulphur.

23.

TELLURIUM AND ITS COMPOUNDS.

Of no use in the arts. Rarely occurs native, when it is a white and brittle metal, which is easily fusible, with greenish flame. It fumes strongly, and, in presence of selenium, gives the peculiar odor of decomposing horse-radish. Usually combined with the other metals as tellurides of gold, silver, lead, and bismuth, which see. In open tube a white or grayish sublimate is obtained, which may be fused to clear, colorless drops. Soluble in nitric acid.

24.

TIN AND ITS COMPOUNDS.

Fused with soda and borax on charcoal in R. F., the compounds of tin yield a globule of the metal. At the same time a coating is formed on the coal which is slightly yellow when hot, but white when cold. To obtain a coating, however, the assay must be kept covered with the blue R. F. The coating moistened with cobalt solution, and heated in the O. F., assumes a bluish-green color. Sulphides should always be roasted. When a solution of salts of tin, acidulated with HCl, is brought in contact with metallic zinc, metallic tin is thrown down in the form of scales or as a gray spongy mass.

25.

TUNGSTEN AND ITS COMPOUNDS.

Before blowpipe compounds of tungsten impart to salt-of-phosphorus bead at first a dirty green, then a blue color when cold. If iron is present, the bead appears blood-red. Best with tin on charcoal. Characteristic reaction is that when boiled with phosphoric acid its compounds give a beautiful blue sirup. Often associated with tin ores.

26.

ZINC AND ITS COMPOUNDS.

Compounds of zinc with borax give a clear glass, which is milk-white on flaming, or with more assay becomes enamel-white on cooling. In the R. F. on charcoal burns with a greenish-blue flame. Fumes are given off, depositing *much* oxide, which coating is yellow when hot, but white when cold. With soda on charcoal the ores, even when containing little zinc, afford the *peculiar bluish flame* of burning zinc, and the oxide is deposited on the coal. When this coating is moistened with cobalt nitrate, a fine yellowish or dirty-green color is obtained (either alone or with soda), while tin gives a bluish-green color when similarly treated.

END OF PART I.



PART II.

I.—TABLES.

NAME.
COMP. AND
PERCENTAGE
OF IMPORTANT
CONSTITUENT.

GENERAL CHARACTERS AND ASSOCIATIONS.

SPECIFIC

BEFORE BLOWPIPE.

ALUMINUM AND ITS COMPOUNDS.

Heated on charcoal or forceps in O. F. with cobalt nitrate and reheated gives a blue color. A blue infusible mass only forms many useful alloys, e.g., aluminum bronze and ferro-aluminum in making and casting steel, etc. Many articles are made entirely from, such as ingots, sheets, wire, etc. Its ores, especially bauxite, are also largely used for the manufacture of aluminum salts or

The ores of Aluminum are:	Al_2O_3 , H_2O , or $\text{Al}_2\text{Fe}_3\text{O}_8$, + $2\text{H}_2\text{O}$. Variable.	Occurs as irregularly round concretions—rarely amorphous. Concretionary structure never wholly absent. Pebble-like, pisolithic, oolitic, vesicular, and amorphous. Origin ascribed to deposition of solutions contained in waters of thermal springs and geysers, though often due to decay of certain rocks, and found in the residual clay. Gives much water in closed tube. Common impurities—silica, iron, and titanic acid. Other accidental impurities are phosphoric acid, sulphuric acid, carbonic acid, lime, magnesia, etc. Presence of titanium characteristic. (Compare kaolinite.) Some European deposits form more or less stratified beds, but the Georgia and Alabama deposits are superficial and pockety. Deposits in these states usually occur in connection with Silurian rocks (dolomite), but supposed to have been formed in Tertiary times. French deposits occur in connection with Cretaceous limestone and are interbedded with lacustral formations. (See 16th An. Rep. U. S. Geol. Sur., part III—Mineral Resources, 1894, p. 547 et seq.) Frequently associated with iron ore and sometimes mistaken for honeycombed impure iron ore.
Cryolite.	$\text{Na}_3\text{Al}_2\text{F}_{12}$. Aluminum 12.8%. Sodium 32.8%. Fluorine 54.4%.	Easily fusible in flame of candle. Massive, cleavable, brittle, fracture uneven. Only workable quantities known in Greenland. Said to be found there in a large vein in gneiss, and to be associated with galena, blonde, siderite, cassiterite, pyrites, fluor-spar, etc. Also sparingly in quartz veins in granite in Colorado.
		In the forceps fuses easily, coloring flame yellow. On charcoal fuses to a clear bead which becomes opaque on cooling. In the open tube when so heated that the flame enters the tube, hydrofluoric acid is driven off, etching the glass.

CHARACTERS. TREATMENT WITH ACIDS, ETC.	COLOR.	LUSTRE.	STREAK	FUSI- BILITY.	HARD- NESS.	SP. GR.	CRYs- TALLI- ZATION.	MAGNETIC BEFORE OR AFTER HEATING.	USES.
indicates alumina. (See Heating with Cobalt Nitrate in Appendix.)— <u>Uses.</u> —Of rapidly increasing commercial importance. from it where light weight, durability, and non-liability to tarnish, as well as other metallic attributes, are desirable. Made into many compounds, especially alums.	White, brown, and red to black. Also cream- or pearl-white, grayish, yellowish, amber, pinkish. Frequently mottled and iron-stained	Dull.	Earthy or like color.	Infus. or above	Vari- able. 5.	2.55		Usually slightly after.	In addition to being used as an ore of aluminum, it is very largely used in the manufacture of alum, for which purpose the insoluble matter should not exceed 7%, nor the oxide of iron 2.75%. Also used in the manufacture of very high-grade and refractory crucibles and fire-brick.
No effervescence when heated with HCl. Soluble in sulphuric acid with evolution of hydrofluoric acid.	White, reddish to brownish, and rarely black.	Vitreous to greasy.	White, etc.	I	2.5	3	V.		In addition to being to a limited extent an ore of aluminum, and used in the manufacture of alums, cryolite is used in the manufacture of a porcelain-like glass. It is also used in the manufacture of chemically pure soda.

NAME.	COMP. AND PERCENTAGE OF IMPORTANT CONSTITUENT.	GENERAL CHARACTERS AND ASSOCIATIONS.		SPECIFIC BEFORE BLOWPIPE.
Alum.	Very vari- able.	The alums proper, which may be fibrous or massive or mealy or in solid crusts, are hydrous sulphates of alumina with an alkali metal and 24 molecules of water. Thus potash alum (kalinite) has formula $K_2SO_4 \cdot Al_2(SO_4)_3 \cdot 24H_2O$, while soda alum (mendozite) has formula $Na_2SO_4 \cdot Al_2(SO_4)_3 \cdot 24H_2O$. That is to say, the former contains sulphur trioxide, 33.7; alumina, 10.8; potash, 9.9; water, 45.6; and the latter contains sulphur trioxide, 34.9; alumina, 11.1; soda, 6.8; water, 47.2. The former is much more common. Alum effloresces on argillaceous minerals and particularly alum shales. More or less common. A more or less common variety is halotrichite, or iron alum, where either magnesium, iron, manganese, etc., are present; e.g., samples from New Mexico contain sulphur trioxide, 37.19; alumina, 7.27; iron protoxide, 13.59; insoluble, 0.50. (Dana.) NOTE. —Ammonia alum (comparatively rare in nature) is now extensively manufactured from the waste of gas-works, and is used in the place of potash alum.		Generally fuses in its own water of crystallization and froths, forming a spongy mass. Intense blue when moistened with cobalt solution. On charcoal forms a hepatic mass.
ANTIMONY AND ITS COMPOUNDS.	Native Sb. (rare).	When strongly heated in closed tube yields a sublimate near assay, which is black when hot and crystals in coating far from assay are octahedrons; those near assay needle-like (use lens). Sublimate in aqua regia or hot H_2SO_4 . When native takes fire and continues to burn without further heating, in general rendering metals more lustrous, hard, and brittle. When alloyed with lead it is largely used in the to a small extent in medicine. Alloyed with lead it is also used in alkali-works for making pumps and taps for Sometimes occurs in nature alloyed with other metals, such as arsenic, silver, and nickel.		

CHARACTERS.	COLOR.	LUSTRE.	STREAK	FUSIBILITY.	HARDNESS.	SP. GR.	CRYSTALLIZATION.	MAGNETIC BEFORE OR AFTER HEATING.	USES.
TREATMENT WITH ACIDS, ETC.									
Generally soluble in 20 times its weight of cold water, and very much less in boiling water.	Generally white to yellowish white.	Vitreous to silky. Transparent and translucent, but varieties become dull on exposure.	White	Easily	2-3	1.75-1.90	I, also V and VI.		Used in the manufacture of paper, dyes, and baking-powders; also in tanning leather, and in clarifying or filtering turbid or impure water. Aluminate of sodium is used in calico-printing and the saponification of fats, and in the manufacture of stearine candles, etc.

brown-red when cold. Characteristic dense white fumes. On charcoal white sublimate near assay, bluish distant from assay; less volatile than that of arsenious acid. H_2S passed through acidified antimonial solution gives orange precipitate. Dissolved and becomes covered with white needles of antimony oxide.—Uses.—Its chief use is as an alloy with other metals, an admixture in manufacture of type-metal. It also forms part of the anti-friction metals, such as babbitt metal, employed for bearings in machinery, and raising and drawing off acids.

NAME. COMP. AND
PERCENTAGE
OF IMPORTANT
CONSTITUENT.

GENERAL CHARACTERS AND ASSOCIATIONS.

SPECIFIC

BEFORE BLOWPIPE.

ANTIMONY AND ITS COMPOUNDS.—Continued.

Stibnite. Sb₂S₃.
(Anti-mony Glance).
The other ores are comparatively rare.

Antimony,
71.4%.

Burns in flame of candle. Slightly sectile. Almost the entire supply of commerce is derived from this ore.
Usually associated with silver, lead, copper, etc., in many veins and other classes of deposits in which the ores of these metals occur. Frequently met with throughout the Rocky Mountain region. Occurs with quartz in veins in clay-slate in Arkansas, but, like the other ores with which it is found, occurs in many kinds of rock.

Volatilizes and gives off white fumes and a sulphurous odor. Fuses easily and colors flame greenish blue. On charcoal fuses and gives white coating which volatilizes when R. F. is turned upon it, coloring flame green-blue.

Cervantite
(Kermesite)
(Sb₂OS₃)
is cherry-red variety.

Sb₂O₄.
Antimony,
78.9%.

Antimony oxide resulting from decomposition of stibnite and other ores of antimony.

Infusible, but easily reduced on charcoal.

(White anti-mony)
Valentinite.

Sb₂O₃.
Antimony,
83.3%.

Becomes yellow in flame of candle and fuses to a white mass. Much the same as stibnite.
Translucent to subtransparent.

CHARACTERS. TREATMENT WITH ACIDS, ETC.	COLOR.	LUSTRE.	STREAK	FUSI- BILITY.	HARD- NESS.	SP. GR.	CRYs- TALLI- ZATION.	MAGNETIC BEFORE OR AFTER HEATING.	USES.
In closed tube, black to brown sublime when hot, which becomes brown-red on cooling. Yellow sublimate of sulphur further up the tube. When pulverized and treated with potassa is rapidly colored ochre-yellow and mostly dissolved. Soluble in hydrochloric acid when pure.	Lead-gray to steel-gray.	Metallic to splen-dent.	Gray and shin-ing tar-nish. Like color.	I	2	4.5	IV.		See under heading ANTIMONY, etc.
Reacts for antimony. Soluble in HCl.	Yellow, white, and reddish white.	Pearly or greasy, sometimes earthy.	Yel-lowish white to white	Infu-sible.	4.5	4.08	IV.		See under heading ANTIMONY, etc.
Insoluble in water. Dissolves readily in HCl without evolution of gas.	White, sometimes red or gray.	Pearly or adamantine	White	I	2.5	5.57	IV.		See under heading ANTIMONY, etc.

NAME.	COMP. AND PERCENTAGE OF IMPORTANT CONSTITUENT.	GENERAL CHARACTERS AND ASSOCIATIONS.	SPECIFIC BEFORE BLOWPIPE.
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ANTIMONY AND ITS COMPOUNDS.—Continued.

Ker-mesite—cherry-red variety.	Sb ₂ OS ₃ .	Oxysulphide resulting from decomposition of stibnite, etc.	On charcoal much the same as stibnite.
	Antimony, 75%.		
Apatite (Phosphorite).	3Ca ₃ P ₂ O ₁₀ + CaF ₂ .	Reacts for phosphorus. (See phosphate rock.) Distinguished from <i>beryl</i> by its inferior hardness, being easily scratched with a knife; from <i>calcite</i> by no effervescence with acids; from <i>pyromorphite</i> (lead phosphate) by its difficult fusibility, and giving B. B. no metallic reaction. The last affords B. B. a globule which becomes angular or crystalline on cooling. Brittle, transparent to opaque.	In forceps infusible except at edges, coloring flame reddish yellow; moistened with H ₂ SO ₄ , colors flame feebly green.
Phosphate of lime, 92.25%.		Occurs in rocks of various kinds, but more frequently in those of a metamorphic crystalline character, as in Laurentian gneiss, which is usually hornblendic, granitic, or quartzose in character, in Canada, and in association with granular limestone. Also found in veins traversing granite and in many metalliferous veins, also disseminated in beds of iron ore and in mica schist, and sometimes associated with tin in gneiss, syenite, etc. Frequently found associated with such minerals as pyroxene, amphibole, titanite, zircon, garnet, etc., etc.	

CHARACTERS.	COLOR.	LUSTRE.	STREAK	FUSIBILITY.	HARDNESS.	SP. GR.	CRYSTALLIZATION.	MAGNETIC BEFORE OR AFTER HEATING.	USES.
TREATMENT WITH ACIDS, ETC.									
In open tube reacts like stibnite.	Cherry-red.	Adamantine to metallic.	Brown-red.	I	1.5	4.6	V.		See under heading ANTIMONY, etc.
Slowly soluble in nitric acid. Insoluble in dilute HCl. Acetate of lead added to nitric solution (not too acid) causes a heavy precipitate of phosphate of lead. Molybdate of ammonium added to solution gives a bright yellow precipitate. In a closed tube it affords no water.	Variable, but generally tinged sea-green or grayish green, yellow, blue, brown, red and gray, sometimes colorless.	Vitreous, never bright, inclining to sub-resinous	Whitish.	Quietly at 5.	5	3.20	III.		The principal use of apatite is as a source of phosphoric acid and phosphorus, and before the discovery of the phosphate-rock deposits in Florida was largely sold to the manufacturers of fertilizers, its value for them, as in the case of phosphate rock, depending upon the percentage of phosphate of lime which it contains. (See phosphate rock.)

NAME.	COMP. AND PERCENTAGE OF IMPORTANT CONSTITUENT.	GENERAL CHARACTERS AND ASSOCIATIONS.	SPECIFIC BEFORE BLOWPIPE.
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ARSENIC AND ITS COMPOUNDS.

Heated on charcoal volatilizes with white incrustation, which is deposited far from assay, and which is easily driven off by assay, with alliaceous fumes. When flame is applied to this sublimate it volatilizes, and the characteristic brilliant but minute small quantities are mixed with lead it is used in the manufacture of small shot. When added to iron and steel it is used for the man-useful articles being made from the alloy. Also used to a certain extent in agriculture, in the manufacture of certain kinds of glass, and

NOTE.—Considerable quantities are now obtained from the reduction of cobalt and nickel ores as a by-product.

Native.	As.	Very brittle and friable. Easily pulverized. Soon oxidizes on exposure, producing black crust. Occurs principally in veins in crystalline rocks associated with ores of antimony, lead, silver, etc.	Volatile at 356° without undergoing fusion, and burns with pale-bluish flame when heated just below redness. Gives a white coating on coal, and affords a garlic odor.
Arseno-pyrite (Mis-pickel).	FeAsS. Arsenic, 46.0%.	Common ore. Brittle. When associated with nickel and cobalt ores it reacts for these two metals. Found principally in crystalline rocks, associated with ores of lead, silver, tin, also with pyrite, chalcopyrite, and sphalerite.	Gives fumes of arsenic; in R. F. becomes black and attractable by the magnet, owing to presence of iron. In closed tube first red sublimate, then lustrous black sublimate of metallic arsenic; in open tube sulphurous fumes and white sublimate of arsenic trioxide.
Orpiment.	As ₂ S ₃ . Arsenic, 61.0%.	Small crystals with smooth surface, and irregularly clustered together or in foliated or fibrous masses. Found associated with realgar, native arsenic, and calcite.	Reacts for arsenic and sulphur. Fuses readily and volatilizes, and with soda on charcoal gives arsenical fumes and a blue flame.

CHARACTERS. TREATMENT WITH ACIDS, ETC.	COLOR.	LUSTRE.	STREAK	FUSI- BILITY.	HARD- NESS.	SP. GR.	CRY- STALLI- ZATION.	MAGNETIC BEFORE OR AFTER HEATING.	USES.
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the flame. When abundant easily recognized by garlic odor of the fumes. In closed tube gives brilliant black sublimate near octahedral crystals of oxide of arsenic are deposited further up the tube.—USES.—Used in dyeing and calico-printing. When facture of chains and ornaments, the combination affording a brilliant polish. It is also alloyed with copper, many ornamental and in medicine. The ores were used to a greater extent formerly than now in the production of certain colors.

Gives in closed tube metallic arsenic.	Tin-white, light to lead-gray, tarnishes grayish black.	Metallic.	Tin-white, etc., like color.	Vol. without fusion.	3.5	5.7	III.		See under heading ARSENIC, etc.
Reacts for arsenic, sulphur and iron. Soluble in nitric acid, with separation of sulphur. In solution ammonia gives reddish-brown precipitate (ferric hydrate).	Silver-white to steel-gray.	Metallic.	Gray-black.	2	5.5	6.2	IV.	After.	See under heading ARSENIC, etc.
Soluble in aqua regia and caustic potash. HCl precipitates from this latter solution lemon-yellow flocks.	Fine golden or lemon-yellow.	Pearly, resinous.	Paler yellow than color.	Easily	1.5	3.5	IV.		See under heading ARSENIC, etc.

NAME.	COMP. AND PERCENTAGE OF IMPORTANT CONSTITUENT.	GENERAL CHARACTERS AND ASSOCIATIONS.	SPECIFIC BEFORE BLOWPIPE.
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ARSENIC AND ITS COMPOUNDS.—Continued.

Realgar.	AsS.	Easily recognized by its color, etc. Sectile, granular, compact or incrusted.	On charcoal same as above. In closed tube melts, volatilizes, and makes a transparent red sublimate. In open tube when heated carefully yields white sublimate of arsenic tri-oxide.
Arsenic, 70.1%.		Often associated with orpiment and ores of silver, etc.	
Asbestos (Mountain Cork; Moun- tain Leather).	(CaMgFe) SiO ₄ .	Several varieties. Finely fibrous (<i>amianthus</i>) and fibres easily separable. Variety of hornblende (<i>actinolite</i>) or, commercially speaking, of serpentine. Variable. Chrysotile (commercial asbestos) is largely mined in the serpentine belt of Canada, Province of Quebec, where it is usually found filling small cracks or seams in the fractured serpentine. True <i>asbestus</i> , mineralogically considered, is of but small economic importance.	Gives same reaction as hornblende, which see.

CHARACTERS. TREATMENT WITH ACIDS, ETC.	COLOR.	LUSTRE.	STREAK	FUSI- BILITY.	HARD- NESS.	SP. GR.	CRY- STALI- ZATION.	MAGNETIC BEFORE OR AFTER HEATING.	USES.
Dissolves with difficulty in aqua regia, sulphur being precipitated. Boiled with caustic potash is decomposed, leaving a brown powder undissolved.	Light or aurora-red, scarlet-red to orange-yellow.	Resinous, translucent to transparent.	Aurora-red to orange-red.	Easily	1.5-2	3.5	V.		Besides being an ore of arsenic, it is somewhat used in the manufacture of fireworks, especially for the production of what is known as White Indian Fire.
The pure variety is distinguished from some varieties of fibrous serpentine which much resemble it (e.g., chrysotile, commercially sometimes known as <i>bostonite</i>) by yielding no water in closed tube and not being readily acted upon by acids. <i>Chrysotile</i> , or the asbestos of commerce, affords much water in closed tube.	White, greenish white, green, yellow, brownish.	Fibrous, silky or satin-like.	White, slightly shiny.	6. Around edges	5.5 or 2.5-4	3.2 or 2.5-2.6	V.		It is largely used for fire-proof clothing (for which the fibres must be long), for the packing of pistons and valves, for the covering of steam pipes and boilers, and in many other cases where such fire-proof and non-conducting material as asbestos-cloth may be desirable. It is also used in making liquid and fire-proof paints, fire-proof cements, sheet and roll millboard and flooring, and in combination with hair-felts and other substances.

NAME.	COMP. AND PERCENTAGE OF IMPORTANT CONSTITUENT.	GENERAL CHARACTERS AND ASSOCIATIONS.	SPECIFIC BEFORE BLOWPIPE.
Barite (Heavy-spar; a Vein-stone).	BaSO ₄ .	<p>Usually recognizable by its weight, and the fact that it decomposes and colors the flame yellowish green when ignited in forceps. (See Flame Colors in Appendix.)</p> <p>Often found in connection with and as the gangue of many of the metallic ores, such as cobalt, lead, manganese, etc.; also with silver, copper, etc. Occurs throughout the Rocky Mountain region and Missouri and elsewhere—in New Jersey, North Carolina, Virginia, etc. It is rarely found in connection with gold ore, e.g., Huanaco, Chile.</p>	Distinguished from lead carbonate by the foregoing, and the fact that it yields on charcoal no metallic globule, and does not react for lead. On charcoal reduced to a sulphide. With soda gives at first a clear pearl, but on continued blowing yields a hepatic mass, which spreads out and soaks into the coal. If a portion of this mass be removed, placed on a clean silver surface, and moistened, it gives a black spot of silver sulphide. Should the barite contain calcium sulphate, this will not be absorbed by the coal when treated in powder with soda. (Dana.)

BISMUTH AND ITS COMPOUNDS.

Its presence is detected by characteristic lemon or orange sublimate, which it and its compounds give when treated alone or Readily dissolved by nitric acid, which solution, when concentrated, gives white precipitate when poured into excess of water. The metals, e.g., in the manufacture of pewterers' solder, mosaic gold, etc.; also used in the manufacture of type-metal and fusible metal. The colors, while the basic nitrate is used as a cosmetic and in medicine. The ores follow.

CHARACTERS.	COLOR.	LUSTRE.	STREAK	FUSI-BILITY.	HARD-NESS.	SP. GR.	CRYSTAL-LIZATION.	MAGNETIC BEFORE OR AFTER HEATING.	Uses.
TREATMENT WITH ACIDS, ETC.									
With soda gives sulphur reaction. Insoluble in acids.	Generally whitish, but of all colors —yellow, brown, blue, etc.	Vitreous to resinous; sometimes pearly translucent.	Whitish.	3	3	4.5	IV.		Used chiefly in the manufacture of pigments, as a cheaper substitute for white lead, or in the adulteration of the latter. It is also used to a much smaller extent as a makeweight by paper manufacturers, and in the preparation of canvas covers, etc.



with soda on charcoal before blowpipe in R. F. With sulphur and potassium iodide gives a scarlet coating far from the assay. Ores are rare, the supply being furnished principally by the native metal. —USES.—Principally used as an alloy with other salts are quite extensively employed for various purposes, the oxide with boric and silicic acids being used for optical glasses, for porcelain

NAME.	COMP. AND PERCENTAGE OF IMPORTANT CONSTITUENT.	GENERAL CHARACTERS AND ASSOCIATIONS.	SPECIFIC BEFORE BLOWPIPE.
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BISMUTH AND ITS COMPOUNDS.—Continued.

Native.	Bi.	Brittle and somewhat malleable. Occurs in arborescent shapes; foliated and granular. Found usually in connection with ores of cobalt, nickel, silver, lead, and zinc, and sometimes iron; also in quartz with wolframite, scheelite, blonde, and galena.	Fuses easily, with odorless fumes, and does not continue to burn after removal from the flame. The globule is brittle when cold, but somewhat malleable when heated. Volatilizes after long blowing, and imparts to the coal at first a white coating, which becomes partly yellow and partly orange. The color slightly fades on cooling and becomes lemon-yellow. In glass tube it yields scarcely any fumes, and the metal becomes surrounded with fused oxide of a dark-brown color, which changes to yellow on cooling. By this deportment it can be easily distinguished from native antimony and tellurium.
Bismuth Glance (Bismuthin- ite or Sulphide of Bis- muth).	Bi_2S_3 . Bismuth, 81.2%.	Opaque, soft, and brittle. Fuses in flame of candle. Found in connection with tin, gold, and other metallic ores, such as pyrite, chalcopyrite, magnetite, limonite, etc.; also with garnet, barite, apatite, etc.	Fuses in R. F., with effervescence, giving a globule of bismuth and characteristic coating. In open tube sulphurous fumes and white sublimate which B. B. fuse into drops, brown when hot and yellow on cooling.

CHARACTERS. TREATMENT WITH ACIDS, ETC.	COLOR.	LUSTRE.	STREAK	FUSI- BILITY.	HARD- NESS.	SP. GR.	CRY- STALLI- ZATION.	MAGNETIC BEFORE OR AFTER HEATING.	USES
In nitric acid soluble without difficulty. The concentrated solution yields a white precipitate on addition of much water.	Reddish silver-white. Subject to tarnish.	Metallic.	White like color.	I	2.5	9.7	III.		See under heading BISMUTH, etc.
Soluble in nitric acid. Water added causes solution to become turbid, and finally yields a white precipitate of bismuth oxy-nitrate.	Tin-white to lead-gray, sometimes yellowish white.	Metallic.	Gray, sometimes with iridescent tarnish.	I	2	6.5	IV.		See under heading BISMUTH, etc.

NAME.	COMP. AND PERCENTAGE OF IMPORTANT CONSTITUENT.	GENERAL CHARACTERS AND ASSOCIATIONS.	SPECIFIC BEFORE BLOWPIPE.
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BISMUTH AND ITS COMPOUNDS.—Continued.

The other	Bi_2O_3 . ores, which are rare, are:	An earthy oxide of bismuth. Massive and disseminated. Due usually to oxidation of the other ores. Iron and other impurities often present. Rare. Bismuth, Bismuth Ochre.	On charcoal fuses and is easily reduced to metallic bismuth.
Tetradymite.	$\text{Bi}_2(\text{TeS})_3$. Bismuth, 59%.	Compound of bismuth and tellurium. Soils paper. Laminæ flexible. Almost always associated with gold ores.	In open tube grayish-white sublimate which fuses to colorless drops B. B. On charcoal volatilizes and tinges flame bluish green.
Wittichite.	$\text{Cu}_2\text{Bi}_2\text{S}_3$. Bismuth, 42.1%.	Cupreous bismuth.	On charcoal fuses, throwing out sparks; residue treated with soda in R. F. yields a globule of copper.
Bismutite.	$2\text{Bi}_2\text{C}_2\text{O}_4$. + $9\text{H}_2\text{O}$ (?). Variable.	A hydrated carbonate of bismuth; another product of atmospheric action upon native bismuth. In incrustations, often earthy or pulverulent. Variable in composition.	Easily reducible to metallic state and gives yellow coating on coal. In closed tube decrepitates and gives off water.
Borax (Borate of Soda).	$\text{Na}_2\text{B}_4\text{O}_7$. + $10\text{H}_2\text{O}$. Boron tri- oxide = 36.6%. Soda = 16.2%.	Taste slightly alkaline and sweetish. Soluble in water. Conchoidal fracture. Translucent to opaque. Most abundant in India and Thibet, where it is called <i>Zincal</i> . Also quite abundantly found in the Tuscan lagoons and in California, Borax Lake, etc.	Bubbles, swells up, and fuses to clear bead. Fused with fluor-spar and bisulphate of potassium colors flame around assay clear green. This reaction is best performed on platinum wire.

CHARACTERS. TREATMENT WITH ACIDS, ETC.	COLOR.	LUSTRE.	STREAK	FUSI- BILITY.	HARD- NESS.	Sp. Gr.	CRY- STALLI- ZATION.	MAGNETIC BEFORE OR AFTER HEATING.	Uses.
Soluble in nitric acid.	Yellowish to grayish white, rarely verging on apple-green.	Adamantine to dull.	Dull white, earthy	Easily	1	4.3	IV.		See under heading BISMUTH, etc.
Soluble in nitric acid with separation of sulphur if present.	Pale steel-gray.	Splendent, metallic.	Like color.	Easily	1.5-2	7.5	III.		See under heading BISMUTH, etc.
Soluble in HCl with evolution of hydrogen sulphide.	Steel-gray.	Metallic.	Black	Easily	3.5	4-5	IV.		See under heading BISMUTH, etc.
Dissolves with effervescence in HCl; does not gelatinize, but affords a deep-yellow solution.	White, grayish to yellow.	Dull but vitreous when pure.	Greenish gray to colorless.	Easily	4-4.5	7	Amorphous		See under heading BISMUTH, etc.
Reaction alkaline. Treated with acids it does not effervesce. Moistened with strong sulphuric acid gives green flame. Boiling water dissolves double its weight of this salt.	White, grayish, bluish, and greenish.	Vitreous, resinous, or earthy.	White	Easily	2-2.5	1.72	V.		It is used chiefly as a flux in analytical and metallurgical operations, as an aid in welding and soldering, in enamelling and pottery-glazing, and in the manufacture of glass and artificial gems. It is also used in medicine, and quite largely by meat-packers and others as an antiseptic. It has a number of other uses in the various industries.

NAME.	COMP. AND PERCENTAGE OF IMPORTANT CONSTITUENT.	GENERAL CHARACTERS AND ASSOCIATIONS.	SPECIFIC BEFORE BLOWPIPE.
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CALCIUM AND ITS COMPOUNDS.

The presence of calcium may be often detected by the fine orange-red color which its compounds impart to blowpipe precipitate (CaCO_3) which is soluble in acids, with effervescence (CO_2).

Calcite. (Calc Spar) (a Vein- stone, etc.). Many varie- ties.	CaCO_3 . = 100 or Lime = 56%, etc.	Usually shows distinct rhombohedral cleavage. Easily scratched with knife. When deposited from calcareous springs (usually hot) or streams, or in caverns, called variously calcareous sinter, travertine, stalactites, stalagmites, Mexican onyx, etc., in which the peculiar and often beautiful banded appearance is due to the edges of the layers of deposition. Found in seams and veins in the many kinds of rock containing lime, and especially in or in close proximity to limestone strata. It is usually a secondary deposit derived from the dissolving out of the lime from the rocks in or near which it is found, often in veins in connection with and as the gangue of many of the metallic ores. Very common.	Infusible. Held in forceps and moistened with HCl gives yellowish-red or orange color to flame.
Lime- stones (mas- sive).	Generally more or less im- pure.	All common limestones and marbles are essentially only massive calcite or dolomite, usually more or less (See also Flame Colors in Appendix.)	

CHARACTERS. TREATMENT WITH ACIDS, ETC.	COLOR.	LUSTRE.	STREAK	FUSI- BILITY.	HARD- NESS.	SP. GR.	CRYSS- TALLI- ZATION.	MAGNETIC BEFORE OR AFTER HEATING.	USES.
Soluble in cold <i>dilute</i> HCl, with effervescence. The dilute solution gives no precipitate with sulphuric acid, but the strong solution does.	Colorless, white, and of all tints.	Vitreous to earthy. Transparent to opaque.	White or grayish.	Infus	3	2.7	III.		One of the principal uses of calcite and of the purer grades of limestone is as a flux in blast-furnaces and for metallurgical operations. Compact limestone is very largely used as a building-stone, and marble (crystalline limestone) is largely employed for the same purposes, as well as for monumental, sculptural, and ornamental purposes. The clayey as well as the pure varieties are largely used in the manufacture of cements. It is also used in making glass if not containing too much iron or other metallic oxides which color the glass. Limestone is the best and cheapest stone for railway ballast and macadamizing. Used extensively for curbstones, in bridge-building, etc., etc. Large quantities (usually scrap-marble) are used in the manufacture of carbonic acid gas for the many purposes for which this gas is employed, and when calcined it is largely used in making mortar, chloride of lime, and as a fertilizer. Very fine-grained and compact limestone is employed as a lithographic stone, but beds of limestone affording good lithographic stones are very rare. The uses of limestone are much more varied than those of any other rock.

impure from presence of clay or sands. For the different varieties see pp. 266-268, Dana's Min.

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CALCIUM AND ITS COMPOUNDS.—Continued.

Dolomite (CaMg)
(mas- CO₂. Common magnesian limestone. Generally very impure. Distinguished from common limestone by no effervescence with dilute cold HCl, or only very feeble. Much "hydraulic" limestone (so called from the fact that it sets after ignition and becomes solid under water), used in making cements, is here included.

Calcium carbonate

= 54.35.

Magnesium carbonate

= 45.65,

etc.

Frequently associated with serpentine and other magnesian rocks, and with ordinary limestones. Often forms massive and extensive strata. Sometimes associated with gypsum, rock-salt, and other results of the evaporation of saturated saline waters.

Harder than calcite, but sometimes chemical analysis required to distinguish between the two. After ignition reaction alkaline.

Gypsum (mas- CaSO₄
sive). + 2H₂O. Scratched by the nail. Hydrous calcium sulphate. This when compact is so-called alabaster, or when burned plaster of Paris. Frequently associated with beds of rock salt, caliche (Chile salt-peter), etc. Also associated with pyrite, sulphur, etc. It is often produced where the decomposition of pyrites has an opportunity to affect adjacent limestone. Also associated with dolomite and anhydrite.

Becomes instantly white and opaque, and exfoliates, then fuses to a globule, having an alkaline reaction. When ignited at a temperature not exceeding 260° it again combines with water and becomes firmly solid. Gives sulphur reaction with soda in R. F.

CHARACTERS. TREATMENT WITH ACIDS, ETC.	COLOR.	LUSTRE.	STREAK.	FUSI- BILITY.	HARD- NESS.	SP. GR.	CRYs- TALLI- ZATION.	MAGNETIC BEFORE OR AFTER HEATING.	USES.
Effervesces in hot but not in cold hydrochloric acid. Concentrated solution gives with sulphuric acid a precipitate of sulphate of lime.	White, gray, brown, etc.	Vitreous to pearly to dull.	Whitish.	Infus.	3.5-4	2.8	III.		Many of the massive kinds afford good hydraulic lime, and when of the proper color are sometimes used as marble for architectural and ornamental purposes. It is largely used as a building-stone. Often used for the bricks employed in the manufacture of steel by what is known as the "Basic" process. (See magnesium, etc.)
In closed tube gives much water and becomes opaque. Dissolves quietly in much HCl, and the solution gives a heavy precipitate with barium chloride. Soluble in 400 to 500 parts of water.	Colorless to gray dirty-white, and various shades.	Pearly, silky, vitreous. Sometimes dull, earthy.	White	2.5	2	2.3	V.		One of the principal uses is in making plaster of Paris and for the manufacture of artificial marble. It is also used as a fertilizer or land-plaster, and when pure in its natural state it is carved into ornamental objects. It is used also in making certain cements.

NAME.	COMP. AND PERCENTAGE OF IMPORTANT CONSTITUENT.	GENERAL CHARACTERS AND ASSOCIATIONS.	SPECIFIC
			BEFORE BLOWPIPE.
CALCIUM AND ITS COMPOUNDS.—Continued.			
Anhydrite (Variety "Flos- Ferri" or "Flower of Iron")	CaSO ₄ .	It is an anhydrous calcium sulphate; fibrous and lamellar; often contorted; coarse and fine granular and compact. (Compare gypsum.) Found very often with rock-salt and gypsum, into which it often passes by absorption of moisture. Sometimes forms extensive beds.	Reactions same as those of gypsum. Cleaves easily in three directions into square blocks.
Aragonite.	CaCO ₃ .	Much resembles calcite, but is not cleavable parallel to rhombohedron; also distinguished from it by its higher specific gravity and crystalline form. Transparent to translucent. Often found in connection with iron ores and in basalt and trap-rocks. Sometimes associated with copper and iron pyrites, galena, malachite, etc.	Falls to powder, in which it differs from calcite. When containing strontium imparts more of a scarlet color to flame.
Celestite.	SrSO ₄ .	Differs from baryta in the bright-red color of flame (strontium). (See Flame Colors in Appendix.)	With soda in R. F. gives a sulphur reaction. Frequently decrepitates coloring flame red.
Strontium, 47.6%		Usually found in the older formations, in sandstones and especially in limestones. It is commonly associated with gypsum, rock-salt, and sulphur. Occasionally in connection with some of the metallic ores such as galena and sphalerite.	

CHARACTERS.

TREATMENT WITH ACIDS, ETC.	COLOR.	LUSTRE.	STREAK	FUSI-BILITY.	HARD-NESS.	SP. GR.	CRYSTAL-LIZATION.	MAGNETIC BEFORE OR AFTER HEATING.	USES.
Same as with gypsum, except in closed tube it gives no water. Is not precipitated by bichloride of platinum; insoluble in water.	White, or tinged with gray, red, or blue.	More or less pearly, or vitreous, transparent to sub-transparent.	Grayish white.	2-3	3-3.5	2.95	IV.		A scaly variety containing a small amount of silica, and known as <i>vulpinite</i> , is sometimes cut and polished for ornamental purposes.
Behavior with acids same as for calcite, which it much resembles, but from which it is further distinguished by different crystalline form, absence of rhombohedral cleavage, and higher specific gravity.	Colorless; white, with light tinges of gray, yellow, green, and violet.	Vitreous to resinous on broken surface.	Un-colored	Infus.	3.5-4	2.9-3	IV.		May possibly be used for some of the same purposes as calcite, but of small importance in the arts.
Very little acted on by HCl, or HNO ₃ .	Colorless, white, bluish, and reddish.	Vitreous, pearly. Transparent to sub-transparent.	White	3	3-3.5	3.9	IV.		Its principal use is for making nitrate of strontia which is largely employed in producing a red color in fireworks.

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CHLORINE.

This element, though not occurring in a free state in nature, is largely used and frequently met with through the many Chlorides when heated with strong sulphuric acid, save those of mercury, silver, and tin, evolve hydrochloric acid gas, off, recognizable by its irritant odor, green color, power of bleaching litmus, etc., and by the purple stain it produces on a piece of furnish a mass which when warmed with strong sulphuric acid gives off deep-red vapors of chromic chloride, CrOCl_3 , decomposable rendered ammoniacal. (Odling.) Fused in a bead of microcosmic salt saturated with CuO imparts an azure-blue color to chemistry, in the manufacture of chloride of lime, chloride of potassium, etc. Chloride of lime is largely used as a disinfectant and liberated. Chlorine is one of the best disinfectants or deodorizers known, or furnishes the basis for them. It is also quite largely used in

CHROMIUM AND ITS COMPOUNDS.

Exists chiefly in two native compounds, viz., crocoite (Siberia) or chromate of lead, and chromite or oxide of chromium and slightly magnetic. Fuses slightly, is soluble, and imparts a beautiful emerald-green color to beads of borax and salt of phosphorus (the chrome-yellow of commerce). Bichromate of potash (which is the salt from which all the others are obtained) is quite extensively of very hard grades of steel known as chrome steel.

{ Chromite (Chromic Iron).	FeCr ₂ O ₄ .	In many varieties quite strongly magnetic; in others, only very feebly. Usually found associated with serpentine (altered peridotite) in which it forms irregular embedded masses or veins.	In O. F. infusible. In R. F. becomes slightly rounded on edges and becomes more magnetic. Best test is that it imparts a beautiful characteristic emerald-green color to beads of borax and salt of phosphorus when cold. This color is heightened by fusion on charcoal with metallic tin.
	Chromium Sesqui- oxide, 68%.	Sometimes found associated with gold, pyrite, galena, quartz, etc. Commercially speaking, the only ore.	

CHARACTERS.

TREATMENT WITH ACIDS, ETC.	COLOR.	LUSTRE.	STREAK.	FUSIBILITY.	HARDNESS.	SP. GR.	CRYSTALLIZATION.	MAGNETIC BEFORE OR AFTER HEATING.	USES.
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compounds which it forms, such as chloride of ammonium, copper, mercury, potassium, sodium, tin, silver, etc., which see. known by its pungent smell and acid reaction. When heated with peroxide of manganese and sulphuric acid, chlorine gas is given starch-paper moistened with iodide of potassium. When fused with a little carbonate of sodium and red chromate of potassium, they flame.—USES.—Common salt (chloride of sodium) is the form in which chlorine is most frequently met with. It is, however, used in deodorizer. Much the same results have been lately obtained by passing a current of electricity through sea-water, free chlorine being thus the recovery of gold from its ores by what is known as the "chlorination" process.

iron. It is, when reduced to metallic state, a whitish, brittle, and very infusible metal. Chief source is chromite, which is phorus when cold.—USES.—Its compounds are used in imparting a green color to glass and in the production of chromate of lead employed in calico-printing. It also has various other uses. An increasing quantity of chrome-iron ore is being used in the manufacture

Only slightly attacked by HCl, but soluble by fusion in bisulphate of potash or soda.	Iron-black, pitch-black to brown-black.	Sub-metallic to metallic.	Yellowish brown to dark brown	Infus.	5.5	4.3	I.	Both. Sometimes but slightly.	See under heading CHROMIUM, etc.
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NAME.	COMP. AND PERCENTAGE OF IMPORTANT CONSTITUENT.	GENERAL CHARACTERS AND ASSOCIATIONS.	SPECIFIC BEFORE BLOWPIPE.
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CHROMIUM AND ITS COMPOUNDS.—Continued.

Chro- mate of Lead (Croco- ite). Very rare.	PbO ₄ Cr. Chromium trioxide, 31.1%.	This is chiefly manufactured from above, and is known as the "chrome-yellow" of the painter. Occurs very rarely in nature in metamorphic rocks (gneiss or granite), associated with gold, pyrites, galena, quartz, etc.	Blackens and fuses and forms a shining slag containing globules of lead. Gives emerald-green bead in both flames.
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COALS.

These may be generally easily recognized by their physical characters, which are too well known to require description. "It bituminous matter to anthracite, and further to kinds which approach graphite." Each species gives variable analyses according

NOTE.—A *coking* coal is a bituminous coal which softens or becomes pasty or semi-viscid in the fire. This is attended with or less coherent grayish-black cellular or fritted mass is left, which is coke, or the part not volatile, and which varies from 50-85% in general composition, but it burns freely without softening or any appearance of incipient fusion. The "coke" resulting from

Anthra- cite.	C (80-95 p. c.).	Does not take fire in lamp-flame. Hard as compared with other varieties of coal, lustrous, and breaks with conchoidal fracture. Burns with a feeble flame of a pale color.	In closed tube yields a little water and very little tarry product (bitumen). B. B. burns with feeble flame, is slowly consumed, and leaves but little ash.
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CHARACTERS.

TREATMENT WITH ACIDS, ETC.	COLOR.	LUSTRE.	STREAK	FUSIBILITY.	HARDNESS.	SP. GR.	CRYSTALLIZATION.	MAGNETIC BEFORE OR AFTER HEATING.	Uses.
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Reacts for lead and chromium.	Bright red or hyacinth-red.	Translucent and vitreous. Adamantine	Orange yellow to orange	1.5	2.5-3	6	V.		
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passes from forms which still retain the original structure of the wood (peat, lignite) and through those with less of volatile or to amount of impurities present.

escape of bubbles of gas. The volatile products resulting from the decomposition of the softened mass being driven off, a more A *non-coking, free-burning* coal may be like the former in all external characteristics and even in percentage of volatile matter and this is not a proper coke, being often in a powder or in the form of the original coal. (Dana.)

Boiled in solution of potassa it gives no color to liquid.	Black.	Brilliant and lustrous.	Black	With some difficulty.	2-2.5	1.5		Very extensively used as a fuel where great heat and a smokeless fire are desirable; also usually admixed with coke for iron-smelting, as in Pennsylvania and to a less extent in New South Wales.
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NAME.	COMP. AND PERCENTAGE OF IMPORTANT CONSTITUENT.	GENERAL CHARACTERS AND ASSOCIATIONS.	SPECIFIC BEFORE BLOWPIPE.
COALS.—Continued.			
Semi-bituminous.		This is the <i>commercial name</i> of the variety which is intermediate between anthracite and the following, i.e., in being which yield upon analysis, for example, fixed carbon, 70–85%. (Pocahontas Flat-Top Semi-Bituminous.)	
Bituminous Coal (coking and non-coking varieties).	50–85 p. c. residue on being strongly heated.	Burns with bright-yellow smoky flame in the fire, often with elimination of bituminous odor; frequently breaks into cubes. Upon distillation gives out hydrocarbon oils or tar, hence name <i>bituminous</i> . Usually a firm compact texture, but fragile as compared with anthracite.	Burns and leaves comparatively little ash, which varies with the amount of silica, oxide of iron, clay, etc., present as impurities in the coal.
Lignite or Brown Coal (often black).	Very variable.	Air-dried lignite contains frequently 15–20% or more of water, which it loses when dried at 110° C. or 230° F. Very abundant; often impure; not suitable for making commercial coke, or very rarely, and affording large proportion of volatile matter. Variety, Jet.	
Cannel Coal.		A variety of bituminous coal, which differs from the purer varieties in often containing much more extraneous causes it to be much used in <i>enriching</i> gas coals. It is very dense and compact, brown or black in color. Dull splits and crackles or "chatters" without melting; like asphaltum. Burns readily with bright flame. Leaves ash a large proportion of burning or lubricating oils, much larger than bituminous coal. Graduates into oil-producing. The variety <i>Jet</i> (see above) which is used for ornament and jewelry resembles cannel coal, but is harder, of a <i>land</i> , in the manufacture of gas or in enriching other gas coals.	

CHARACTERS.	COLOR.	LUSTRE.	STREAK	FUSI-BILITY.	HARD-NESS.	Sp. Gr	CRYSTAL-LIZATION.	MAGNETIC BEFORE OR AFTER HEATING.	Uses.
TREATMENT WITH ACIDS, ETC.									
less hard than anthracite and containing more volatile matter. Some of the Virginia coals furnish good examples, such as those									
When heated in flask or closed tube yields brown and brownish-yellow tar drops or oil. Imparts but little color to potash solution upon boiling. The powder boiled with ether imparts scarcely any color.	Black.	Black, resinous.	Black. Some-times choc-tomate, pitchy or greasy.	Easily times choc-tomate, pitchy or greasy.	1.5-2	1.14-1.40			The most common fuel for producing power and heat. The following coals are employed for the same purposes. Large quantities of bituminous coal are converted into coke for use in blast-furnaces, smelting plants, and in many other manufacturing industries, as well as for domestic use.
Gives a brown color to liquid when boiled in solution of potassa.	Brown, brown-black to black.	Dull and slightly resinous.	Brown, black-ish to black.	Easily	1.5-2	1.13			

earthy matter, and usually in containing much greater percentage of volatile bituminous substances (hydrocarbons), which fact earthy to brilliant waxy lustre. Not easily frangible, and breaks with uneven or largely conchoidal fracture. When burning it ranging from 3% to 20%. Hard enough to take a polish. Affords on distillation, after drying, 40-66% of volatile matter, including coaly shales. deeper black and higher lustre, and takes a more brilliant polish.—USES.—Used quite largely, as are certain coaly shales (Scot-

NAME.	COMP. AND PERCENTAGE OF IMPORTANT CONSTITUENT.	GENERAL CHARACTERS AND ASSOCIATIONS.	SPECIFIC BEFORE BLOWPIPE.
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COBALT AND ITS COMPOUNDS.

Easily recognized by the characteristic deep sapphire-blue bead in both flames with borax or salt of phosphorus. The insolubility of the black sulphides of nickel and cobalt in dilute HCl suffices to separate these metals from the remaining members. If ferrid-cyanide be added, the precipitate is brown-red. (Do not confound with similar precipitate of copper.) Sometimes suffices to readily distinguish the following ores from arsenopyrite. ——USES.—The principal use is in the preparation of colors, manufacture, for enameling and tinting writing-paper, etc. The smalts and azures of commerce are prepared by fluxing glass with

Smaltite (Nickel variety, Chlo-anthite), Speiss Cobalt.	CoAs ₃ or (CoFeNi)As ₃ Very variable.	Chief ore of cobalt. On charcoal B. B. affords garlic odor of arsenic; fuses to magnetic globule, which with fluxes gives indications of Fe, Co, and Ni. In closed and open tube indicates presence of arsenic. (See Nickel ores.) This and the other ores of cobalt are usually associated with ores of nickel, and sometimes with those of silver, lead, and copper. Sometimes found alloyed in small quantities with nickel in many meteoric irons.	To borax bead imparts intense sapphire-blue color in both flames. Should be first roasted. Presence of large amounts of iron colors bead green.
Cobalt Glance (Cobaltite).	CoAsS. Cobalt, 35.5%.	Next in importance to above. Reaction for cobalt same as above. Cubical crystals, brittle.	Presence of cobalt easily recognized as above.

CHARACTERS.

TREATMENT WITH ACIDS, ETC.	COLOR	LUSTRE.	STREAK	FUSI- BILITY.	HARD- NESS.	SP. GR.	CRY- STALLI- ZATION.	MAGNETIC BEFORE OR AFTER HEATING.	USES.
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sulphurets should be roasted on charcoal before testing with borax, as in other metallic species. Dissolves in nitric acid. The of the group. If ferro-cyanide of potassium be added to solution first made freely ammoniacal, a green precipitate is produced. associated with oxides of manganese. (Missouri and South Carolina.) Largely associated with arsenic, but the blue color of bead *The protoxide has an intense coloring power when vitrified, and forms the basis of all the blue colors used in glass and porcelain protoxide of cobalt. These are also sometimes produced by fusing the protoxide with pure quartz-sand or carbonate of potassium.*

Gives metallic arsenic in closed tube. Concentrated HNO₃, dissolves with separation of arsenious acid, and the solution has generally a rose-red color. Yields with silicate of potassa a blue precipitate; with chloride of barium added to solution, no precipitate.

Tin-white to steel-gray, occasion-ally irides-cent or grayish from tarnish.

Metal-lic.

Gray-black.

Easily

5.5-6

6.8

I.

Slightly after.

See under heading COBALT, etc.

Gives no arsenic in closed tube, but in open tube yieldssulphurous fumes and arsenic sub-limate. With chloride of barium added to dilute nitric solution gives a heavy deposit of BaSO₄.

Silver-white, inclining to red. Also grayish black.

Metal-lic.

Gray-black.

Easily

5.5

6

I.

See under heading COBALT etc.

NAME.	COMP. AND PERCENTAGE OF IMPORTANT CONSTITUENT.	GENERAL CHARACTERS AND ASSOCIATIONS.	SPECIFIC
			BEFORE BLOWPIPE.
COBALT AND ITS COMPOUNDS.—Continued.			
Cobalt Bloom (Erythrite; Peach blossom Ore).	$\text{Co}_2\text{O}_3\text{As}_2 + 8\text{H}_2\text{O}$	Reaction same as above. Possesses foliated structure like mica. Hydrous Cobalt arsenate.	Arsenical fumes, and fuses to blue glass, etc. In closed tube yields water at gentle heat and turns bluish.
Earthy Cobalt (Asbolite).	$\text{MnO}_2\text{CoO CuOH}_2\text{O}$. Variable.	Earthy variety, sometimes associated with bog manganese (wad). Uncommon.	With soda on platinum wire or foil gives manganese reaction (green); but with borax or salt of phosphorus gives a deep blue bead. With tin on charcoal in R. F. sometimes metallic copper.
Cobalt Pyrites (Linnaeite).	$(\text{CoNi})_2\text{S}_4$ or $\text{Co}_2\text{S}_4 =$ Cobalt, 57.9%. Variable quantities of nickel and iron often replace some of the cobalt.	Generally found impure, i.e., admixed with nickel, iron, and arsenic. Found sometimes in metamorphic rocks in association with chalcopyrite, bornite, sphalerite, pyrites, etc.	Roasted mineral gives borax bead sapphire-blue color, and reacts usually for cobalt, nickel, and iron, and sometimes for arsenic.

CHARACTERS. TREATMENT WITH ACIDS, ETC.	COLOR.	LUSTRE.	SMELAK	FUSI- BILITY.	HARD- NESS.	SP. GR.	CRYSTAL- LIZATION.	MAGNETIC BEFORE OR AFTER HEATING.	USES.
In HCl readily dis- solves to rose-red so- lution. When concen- trated appears blue while hot.	Crimson to peach-red to greenish gray.	Pearly adamant- ine to dull.	Paler than color, dry pow- der lavен- der- blue.	2	2	2.9	V.		See under heading COBALT, etc.
Soluble in HCl, with evolution of chlorine. Solution usually blue, turning rose-red on addition of water.	Black.	Dull.	Earthy	Some varie- ties fuse.	2.25	3.1			See under heading COBALT, etc.
Soluble in HNO ₃ , form- ing rose-red solution.	Pale steel- gray, tar- nishing copper-red.	Metal- lic.	Black- gray.	Easily	5.5	4.9	I.		See under heading COBALT, etc.

NAME.	COMP. AND PERCENTAGE OF IMPORTANT CONSTITUENT.	GENERAL CHARACTERS AND ASSOCIATIONS.	SPECIFIC BEFORE BLOWPIPE.
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COPPER AND ITS COMPOUNDS.

Borax bead in O. F. is green when hot, and greenish blue when cold; in R. F. colorless, if saturation be weak, but red with obtained. When combined with the oxides, tin and borax should be used. When ammonia in excess is added to nitric acid roasted before making B. B. test with borax. For traces of copper place drop of suspected solution on platinum-foil; place in with a drop of HCl and ignited B. B. color the flame azure-blue.—USES.—Copper is largely employed in the manufacture of many other purposes. Electrical inventions consume large and, with the advance of the science, constantly increasing quantities of this metal. also used very largely in many important alloys; e.g., with zinc it constitutes brass, and with tin it forms bell-metal and bronze. It is to

Native.	Cu.	Ductile and malleable. Readily recognized. Rapidly oxidizes superficially to greenish rust upon exposure ($\text{Cu}_2(\text{OH})_2\text{CO}_3$). Lake Superior most important region, where it occurs in conglomerate, sandstone, and trap rocks. Often results from oxidation of other copper ores, and found in association with them.	Fuses readily, covered with black oxide (CuO). Moistened with HCl turns flame sky-blue.
Copper Pyrites (Chalcopyrite)	CuFeS_2 . Copper, 34.5%.	Readily distinguished from gold and iron pyrites. Fracture uneven, brittle. Often contains a large quantity of pyrite.	Fuses to steel-gray brittle globule, which is magnetic; with soda the roasted mineral gives a globule of copper containing iron. Gives sulphur fumes on coal. Blue flame with HCl.
Chalcocite (Copper Glance or Black sulphide of copper).	Cu_2S . Copper, 79.8%.	Somewhat resembles argentite, but is not sectile, and affords different results B.B. Solution in HNO_3 covers knife-blade with copper, but similar solution of the silver ore covers copper-plate with silver. This and the following ores, except tetrahedrite, are usually alteration-products of original copper pyrites.	Alone or on coal the fine powder yields a globule of copper after sulphur is driven off. Sometimes contains very small quantities of iron or silver.

CHARACTERS. TREATMENT WITH ACIDS, ETC.	COLOR.	LUSTRE.	STREAK	FUSI- BILITY.	HARD- NESS.	SP. GR.	CRY- STALLI- ZATION.	MAGNETIC BEFORE OR AFTER HEATING.	USES.
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strong saturation when hot; metallic copper and copper-red when cold. On charcoal with soda, a copper-colored globule is solution, the liquid is colored blue; metallic copper is deposited on iron wire or a nail immersed in this. Specimens should be this a piece of zinc: a film of copper will be deposited on the platinum-foil at point of contact. Copper compounds moistened kinds of utensils, in the manufacture of wire and plates for engraving, etc., for sheathing ships, for coinage, and for a vast number of Wire made from this metal is more suitable for conducting the electrical current than wire made from any other metal except silver. It is a certain extent used in the formation of blue and green pigments.

Excess of ammonia to nitric acid solution renders liquid sky-blue in color. Same applies to various ores of copper.	Copper-red.	Metallic.	Copper-red.	3. or 780°C.	3	8.9	I.	See under heading COPPER, etc.
Dissolves in HNO ₃ , with separation of sulphur forming green solution. Reacts for sulphur, copper, and iron.	Brass-yellow, tarnishes, sometimes iridescent.	Shining metallic.	Green-black.	2	3.5-4	4.3	II. After.	See under heading COPPER, etc.
Dissolves in hot HNO ₃ , with residue of sulphur.	Blackish lead-gray. Often tarnished blue or green.	Metallic, dul.	Blackish lead-gray, sometimes shining	Easily	2.5-3	5.5	IV.	See under heading COPPER, etc.

(NAME. COMP. AND
PERCENTAGE
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CONSTITUENT.

GENERAL CHARACTERS AND ASSOCIATIONS.

SPECIFIC

BEFORE BLOWPIPE.

COPPER AND ITS COMPOUNDS.—Continued.

Bornite (Varie- gated Copper Pyrites or Eru- bescite; Peacock Ore).	Cu_2FeS_3 . Copper, 55.5%.	Distinguished from chalcopyrite by its pale reddish-yellow color, and its rapidly tarnishing to bluish and reddish shades of colors. Sometimes admixed with copper glance, when it yields 50-70% of copper.	Fuses in R. F. to brittle gray globule attracted by magnet. Minute specks from crushed globule will, with borax bead, give copper reaction.
Malachite (Copper Car- bonate).	$2\text{CuO}, \text{CO}_2, \text{H}_2\text{O}$. Copper, 57.3%.	Readily distinguished by green color. Fibrous cleavage. Common with other ores of copper, resulting from their alteration.	Decrepitates and blackens. Colors the flame green. With borax fuses to deep green globule. Ultimately affords bead of copper in R. F.
Azurite (Blue Mala- chite).	$3\text{CuO}, 2\text{CO}_2, \text{H}_2\text{O}$. Copper, 55.1%.	As above. Color blue. Common with other ores, etc. Usually accompanying other copper ores, especially malachite and cuprite.	Similar to above.

CHARACTERS.	COLOR.	LUSTRE.	STREAK	FUSI-BILITY.	HARD-NESS.	SP. GR.	CRYSTAL-LIZATION.	MAGNETIC BEFORE OR AFTER HEATING.	USES.
TREATMENT WITH ACIDS, ETC.									
Dissolves with separation of sulphur. Partly soluble in HNO ₃ , when it reacts as above.	Bronze - yellow, purple on exposed edges; also copper - red to brown.	Metallic.	Pale grayish black, slightly shining.	Easily	3	5	I.	After.	See under heading COPPER, etc.
Gives much water in closed tube. Dissolves completely, with effervescence, in HNO ₃ , giving off CO ₂ . This distinguishes it from all other green ores except emerald nickel, q. v.	Grass to emerald-green. Nearly opaque. Crystals translucent.	Silky to dull, earthy.	Paler than color.	2	3-5-4	4	V.		Sometimes it is cut and polished for ornamental purposes. It is also sometimes used as a green pigment, and in the manufacture of the various salts of copper.
As above.	Deep blue.	Pearly and vitreous. Transparent to opaque.	Bluish, lighter than color.	2	4	3-7	V.		See under heading COPPER, etc.

NAME.	COMP. AND PERCENTAGE OF IMPORTANT CONSTITUENT.	GENERAL CHARACTERS AND ASSOCIATIONS.	SPECIFIC BEFORE BLOWPIPE.
COPPER AND ITS COMPOUNDS.—Continued.			
Chrysocolla (Copper Silicate).	$\text{CuSiO}_3 + 2\text{H}_2\text{O}$. Copper, 36%.	Usually in form of incrustations, or filling seams, or botryoidal. Conchoidal fracture and rather sectile. Usually very impure. Usually associated with red copper ore, native copper, and malachite.	Blackens in R. F. and yields water without melting. With soda on charcoal effervesces and yields a globule of copper. Easily soluble in acids. Copper reaction with borax and salt of phosphorus.
Atacamite (Chloride of Copper).	$\text{Cu}_2\text{ClH}_5\text{O}_4$. Copper, 59.3%.	Conchoidal fracture. Brittle. Found as aggregation of crystals. Also massive, granular, fibrous, compact, and as sand. Province of Atacama, Chile. Also in Arizona.	Gives off water in closed tube and forms gray sublimate. B. B. fuses and colors flame azure-blue with a green edge.
Cuprite (Red Oxide).	Cu_2O . Copper, 88.8%.	Commonly crystallized in octahedrons, etc., but often much modified. Also massive, granular, and earthy. Often mixed with oxide of iron.	On coal yields a globule of copper. In forceps fuses and colors flame emerald-green. Unaltered in closed tube.
Melaconite (Black Copper Ore).	CuO . Copper, 79.8%.	A black powder or dull-black masses and botryoidal concretions along with other copper ores. Ordinarily soils fingers when massive or pulverulent. Usually found disseminated among other ores of copper, and sometimes occurs in shining botryoidal concretions or dull friable masses.	Reacts for copper.

CHARACTERS. TREATMENT WITH ACIDS, ETC.	COLOR.	LUSTRE.	STREAK	FUSI- BILITY.	HARD- NESS.	Sp. Gr.	CRY- STALLI- ZATION.	MAGNETIC BEFORE OR AFTER HEATING.	Uses.
Heated in closed tube yields water and blackens (water 20 per cent). Decomposed without gelatinization by acids, silica remaining behind.	Blue to green. Often black to brownish when impure.	Vitreous, shining to earthy.	White when pure.	Infus.	2-4	2.2	Amorphous		See under heading COPPER, etc.
Easily soluble in acids.	Bright emerald to dark green.	Adamantine to vitreous.	Apple-green.	2	3-3.5	3.7	IV.		See under heading COPPER, etc.
Easily and quietly soluble in strong HCl. Concentrated solution gives upon addition of water a white precipitate of subchloride of copper.	Red, cochineal-red to brown-red, but sometimes nearly black.	Earthy, adamantine to sub-metallic.	Brownish red, shining.	Easily	3.5-4	6	I.		See under heading COPPER, etc.
The strong HCl solution gives no precipitate with addition of water. Sometimes effervesces on account of presence of impurities	Iron-gray to black to brown-black.	Metallic to earthy.	Gray-black	With difficulty	3-4	6	V.		See under heading COPPER, etc.

NAME.	COMP. AND PERCENTAGE OF IMPORTANT CONSTITUENT.	GENERAL CHARACTERS AND ASSOCIATIONS.	SPECIFIC BEFORE BLOWPIPE.
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COPPER AND ITS COMPOUNDS.—Continued.

{	Tetra-hedrite (Gray Copper).	$\text{Cu}_3\text{S}_7\text{Sb}_2$. Very variable.	Often a valuable ore of silver, <i>q. v.</i> ; less frequently an ore of copper commercially speaking. Several varieties which show different reactions. A closely related form is <i>tennantite</i> , substantially $\text{Cu}_3\text{As}_2\text{S}_7$, the antimony being replaced by arsenic. In this the copper is often partially replaced by silver (the "gray copper" of local miners) in which the percentage of silver sometimes reaches as much as 14 per cent.	The roasted mineral gives on charcoal, after long heating a globule of copper; often also reacts for iron, antimony, arsenic, and mercury.
	Copper, 52.1%.		This mineral sometimes contains zinc and silver, and occasionally mercury. It is often associated with chalcopyrite, pyrite, sphalerite, galena, and various other silver, lead, and copper ores; also siderite.	
Corun-dum (Emery, common granular variety colored black by magnetite).	Al_2O_3 .	Very hard, being next in hardness to diamond. Sub-varieties are <i>sapphire</i> , <i>ruby</i> , <i>amethyst</i> (oriental), <i>topaz</i> , and <i>emerald</i> , which are transparent or translucent and very valuable as gems. Usually associated with some member of the chlorite group, and a series of aluminous minerals in part produced from its alteration.	Slowly but perfectly soluble in salt of phosphorus to a clear glass. When finely powdered and after long heating with cobalt solution gives a fine blue color.	

CHARACTERS.

TREATMENT WITH ACIDS, ETC.

	COLOR.	LUSTRE.	STREAK	FUSI-BILITY.	HARD-NESS.	SP. GR.	CRYSTAL-LIZATION.	MAGNETIC BEFORE OR AFTER HEATING.	USES.
Reacts for copper, sulphur, and antimony. Frequently copper replaced by iron and zinc, as well as silver and mercury, while antimony is frequently replaced by arsenic and bismuth. Decomposed by nitric acid with separation of sulphur and antimony trioxide.	Flint-gray to iron-black.	Dark gray. Metallic to splen-dent.	Steel-gray to black and to brown and cher-ry-red.	I	3.5-4.5	4.7	I.		See under heading COPPER, etc.
Not affected by acids or by heat, but rendered soluble by fusion with potassium bisulphate.	Blue, red, purple, yellow, green; when less pure gray-brownish, light blue and black.	Often bright, vitreous.	Same as color.	Infus.	9	4	III.		Corundum, and more especially the impure form, crushed to different degrees of fineness, makes the abrading and polishing material known in commerce as emery. This is used either as a powder or mixed with other materials to make it cohere; it is made into various shapes for cutting, abrading, and polishing—e.g., emery-wheels, etc.



NAME.	COMP. AND PERCENTAGE OF IMPORTANT CONSTITUENT.	GENERAL CHARACTERS AND ASSOCIATIONS.	SPECIFIC
			BEFORE BLOWPIPE.
Dia- mond.	C.	Characterized by its extreme hardness. Brittle. Valuable as a gem and for cutting tools. Usually occurs in alluvial or driftal deposits in gravel, sand, or clay, or rarely in consolidated conglomerates or grits, associated with quartz, gold, platinum, octahedrite, rutile, hematite, ilmenite, topaz, corundum, tourmaline, garnet, etc. Supposed to be of original vegetable origin, the carbon having been dissolved and redeposited in some way not understood.	At very high temperatures out of contact with the air it is transformed into a kind of coke, etc., etc. (See Dana's Min., pp. 4-6.)
Emerald (Beryl).	$\text{Be}_3\text{Al}_2\text{Si}_6\text{O}_{18}$ Approx. Silica, 67%. Alumina, 19%. Beryllia or Glucina, 14%.	The distinctive characteristic, bright emerald green color, is supposed to be due to the presence of traces of chromium. Its hardness distinguishes it from apatite, and this character as well as the formation of the crystals from green tourmaline. Found in granite, gneiss, mica schist, dolomite, with phenacite, chrysoberyl, apatite, rutile, etc. Widely distributed, but Muso in New Granada, East Cordillera of the Andes, is the most celebrated locality. North Carolina has furnished some fine gems. The oriental emerald of jewelry is emerald-colored sapphire.	Alone unchanged, or, if clear, becomes milky white and clouded; after protracted heating the edges of splinters become rounded. A small percentage of water and organic matter lost upon ignition, but color usually retained.
Epidote.	Very vari- able.	A lime, iron, aluminum silicate. Quite hard and somewhat harder than chlorite, for which it sometimes may be mistaken. A rather common rock constituent. Associated usually with quartz, calcite, pyroxene, feldspar, chlorite, hornblende, garnet, magnetite, pyrites, etc., especially in old and highly metamorphic formations. Sometimes also in eruptive rocks and in vein deposits.	Fuses with intumescence to a slaggy mass, dark brown in color, which is generally magnetic.

CHARACTERS.								USES.
TREATMENT WITH ACIDS, ETC.	COLOR.	LUSTRE.	STREAK	FUSI-BILITY.	HARD-NESS.	SP. GR.	CRYSTAL-LIZATION.	
Unaffected by acids or alkalies.	Colorless to black.	Adamantine.		Infus.	10	3.5	I.	Diamonds, besides being largely used and highly prized as jewelry, are employed for cutting glass, for which purpose the natural edge of a crystal is best adapted. Compact and amorphous varieties known as bort and carbonado are employed for cutting purposes in jewelry. Bort is used as a powder for cutting diamonds and other hard stones, and very frequently when set in the edges of boring tools (diamond drills) the whole stone or fragments are used for drilling holes in hard rock.
Unacted upon by acids.	Bright emerald-green.	Vitreous, transparent to translucent.	White	5.5	7.5	2.6-2.8	III.	Used as a gem when clear and free from flaws.
Partly decomposed by HCl, but when previously ignited, gelatinizes with acid. Decomposed on fusion with alkaline carbonates. (Dana.)	Pistachio-green, brown, yellow, greenish black, gray, etc.	Vitreous, translucent to opaque.	Uncolored, grayish.	3	6-7	3.5	V.	

NAME.	COMP. AND PERCENTAGE OF IMPORTANT CONSTITUENT.	GENERAL CHARACTERS AND ASSOCIATIONS.	SPECIFIC
			BEFORE BLOWPIPE.
Feld- spars. Common rock con- stituents, espe- cially of igneous rocks.	Essentially silicates of alumina, with variable proportions of silicates of potash, soda, magnesia, and lime.	Varieties: <i>Orthoclase</i> .—Potash or common variety. Cleaves in two directions at right angles. All other feldspars cleave at oblique angles. Found in crystalline rocks, being a constituent of granite, gneiss, syenite, etc., and also of the eruptive rocks—porphyry, trachyte, phonolyte, etc. <i>Oligoclase</i> .—Soda-lime variety. Occurrence much the same as above.	Fuses quietly. Colors flame violet or lavender (potassium). (See Flame Colors.) Some specimens give soda flame.
		<i>Albite</i> .—Soda variety. Usually distinguishable from orthoclase by its greater whiteness. Occurrence much the same as above. The above are very variable, and distinguished from quartz by their inferior hardness, the shape of the crystals, and other well-known physical characteristics.	Fuses quietly. Colors flame orange-yellow (sodium). (See Flame Colors.)
Fire-clay.	The clay used for fire-brick should be a nearly pure silicate of alumina and free from lime and the alkalies. Stour-clay used for making bricks vary very widely in composition and in the results obtained. Grades insensibly into association with coal, is in making fire-bricks and retorts for blast-furnaces, for other metallurgical works, and for made in large quantities, and are used for fire-proof partitions, etc., for safe- and refrigerator-linings, and for other of fire-clays are also largely used by paper-manufacturers in glazing and weighting paper. A considerable quantity is		

CHARACTERS.	COLOR.	LUSTRE.	STREAK	FUSI-BILITY.	HARD-NESS.	SP. GR.	CRYSTAL-LIZATION.	MAGNETIC BEFORE OR AFTER HEATING.	USES.
TREATMENT WITH ACIDS, ETC.									
Not acted upon by acids.	Colorless, pale yellow, white, flesh-red, gray, green.	Vitreous to pearly.	Uncolored.	5	6	2.5	V.		The chief use of feldspar is in the manufacture of certain kinds of pottery, for which the purer grades are very desirable. Orthoclase is used in a finely powdered state as a glaze for porcelain and to a small extent in jewelry, though sunstone (aventurine feldspar) and moonstone are mostly oligoclase.
Not acted upon by acids.	White and flesh-red.	Vitreous, etc.	Uncolored.	3.5	6-7	2.6	VI.		
Not acted upon by acids.	Colorless, white, dull green.	Vitreous, etc.	Uncolored.	4	6-6.5	2.6	VI.		When found in abundance it is used like the above in the manufacture of the finer kinds of pottery.

bridge clay contains from 60% to 70% silica and from 20% to 30% alumina, with traces only of iron and lime. Of course the kinds of pure kaolin, *q. v.*—USES.—The principal use of the purer and whiter clays, and the clay, if suitable, found so generally in stratified gas-works. Refractory clay is also used for making sewer-pipe, water-pipe, and chimney-tops. Porous brick and terra-cotta lumber are purposes where nonconducting and fire-proof materials are required. Roofing-tiles and hollow bricks are also made. The purer forms used in the manufacture of alum. Ordinary building-brick is made from the much more impure and common varieties of clay.

NAME.	COMP. AND PERCENTAGE OF IMPORTANT CONSTITUENT.	GENERAL CHARACTERS AND ASSOCIATIONS.	SPECIFIC
			BEFORE BLOWPIPE.
Fluor-spar (Fluorite). Common vein-stone.	CaF ₃ .	Characteristic phosphorescence on heating is distinguishing feature. It is valuable as a fluxing material, for which purpose it is often preferred to carbonate of lime. Not very abundant in the United States. Frequently occurs in veins in connection with and as the gangue of many of the metallic ores, especially of lead. The veins may traverse nearly any kind of ore, but fluor-spar is usually found in gneiss, mica-slate, clay-slate, limestone, sandstones, and sometimes in volcanic breccia.	When gently heated gives out greenish or purplish phosphorescence temporarily and colors flame red. Turns white and decrepitates, and ultimately fuses to an enamel which gives an alkaline reaction on test-paper.
Fuller's Earth.		An earthy hydrated silicate of alumina, composed, when pure, of 45% silica, 20% to 25% alumina and water. Like <i>fulling or cleansing of woollen fabrics and cloth, since it was an excellent absorbent of the grease and oil contained in them.</i>	
Garnet. Common rock constitu- ent.	Exceed- ingly variable.	Alumina, iron, and chrome garnets, all brittle. Generally impure and porous. Common in mica schist, gneiss, syenite and chlorite schist, and other metamorphic rocks. Also in crystalline limestone, dolomite, granite, etc., sometimes in serpentine and volcanic rocks, etc.	Most garnets fuse easily to a brown or black glass, but fusibility varies, and chrome garnet is almost infusible. (Compare cassiterite.)

CHARACTERS.	COLOR.	LUSTRE.	STREAK	FUSI- BILITY.	HARD- NESS.	SP. GR.	CRYs- TALLI- ZATION.	MAGNETIC BEFORE OR AFTER HEATING.	USES.
TREATMENT WITH ACIDS, ETC.									
In closed tube decrepitates and generally phosphoresces. Fused with bisulphate of potassa in closed tube yields vapors of hydrofluoric acid, which corrode glass. Same effect when treated with sulphuric acid.	All colors.	Vitreous, transparent to sub- trans- lucent.	Whitish.	3	4	3.2	I.		Fluor-spar is used and is very desirable as a flux in metallurgical processes, as in the reduction of aluminum; also largely in making glass, in the manufacture of hydrofluoric acid, in making paints, enamels, and mineral wool. Sometimes made into very beautiful vases and ornamental objects.

other soft, aluminous minerals, absorbs grease.—USES.—*Fuller's earth was formerly largely used as an absorbent in the Other substances have been substituted, however, and the consumption has fallen off greatly in consequence.*

Not decomposed by HCl, but if first ignited, then pulverized and treated with acid, they are decomposed, and the solution usually gelatinizes when evaporated.	Red to cinnamon-brown, black, green, emerald-green, but rarely colorless.	Vitreous.	White.	Va- rious, 3-6, most varie- ties easily	7	3-4	I.	The fine specimens are principally used as gems. The gem known to the ancients as "carbuncle"—and to a certain extent the term is used at the present day—is simply a deep red variety of garnet cut in a certain fashion. The chief use of the varieties not suitable for gems, especially the variety <i>almandite</i> , is in the manufacture of sand-paper or garnet-paper. It is utilized for abrasive purposes in the manufacture of boots and shoes, and also to a less degree in the woodworking industry. For metals emery is usually preferred. The garnet used in the manufacture of garnet-paper is found to be harder, sharper, and more durable than quartz, and is preferred to quartz for this purpose, though costing many times as much.
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NAME. COMP. AND
PERCENTAGE
OF IMPORTANT
CONSTITUENT.

GENERAL CHARACTERS AND ASSOCIATIONS.

SPECIFIC

BEFORE BLOWPIPE.

GOLD AND ITS COMPOUNDS.

Gold may be generally recognized by its physical characters—color, lustre, malleability, and specific gravity. When a gold regia. If this solution be dropped on to a filter-paper and one drop of stannous chloride be added, a purple-red color is obtained, precipitate being dissolved and tested with stannous chloride, it is separated from the easily volatile metals by simply heating on cupellation. The copper is absorbed into the cupel with the lead, while the silver remains alloyed with the gold. If the globule of silver, which, after fusing on charcoal in O. F., will impart an opaline character to the cool bead. If it be more of a silver-white with nitric acid by application of heat. The silver is thus dissolved, and the gold remains as a dark powder or spongy mass. If native metal. Iron pyrites is frequently found combined with a small percentage of gold, but the other minerals with which it is

Native. Au.

Easily recognized by its physical properties. No cleavage, hackly fracture, and great malleability and ductility. Fuses easily. Is not acted on by fluxes.

The association and distribution of native gold and its ores have to be considered under two heads: (a) as it occurs in mineral veins, and (b) as it occurs in alluvial or other superficial deposits which are derived from the erosion of the region containing these mineral veins or contact deposits. With regard to the first it is found generally in quartz veins or reefs traversing slaty or crystalline rocks, schists, talcose schists, and many kinds of eruptive rocks. It is most frequently associated with quartz and iron pyrites, but is also very often found in connection with galena, blende, magnetic and specular oxide of iron, and other minerals, and also very often with silver ores. It is quite frequently associated with the tellurium minerals, *q. v.* It may be said, generally speaking, that gold is usually found in rocks of a silicious character, and is not often found in basic rocks, although there are many exceptions to this rule. With regard to the second class (alluvial or drift deposits, known as "placers") the associated minerals are generally those of great density and insolubility, such as minerals of the platinum group, tin-stone, chromic iron ore, sometimes precious stones, etc., etc., admixed with quartzose pebbles or sand.

CHARACTERS.

TREATMENT WITH ACIDS, ETC.	COLOR.	LUSTRE.	STREAK	FUSI- BILITY.	HARD- NESS.	SP. GR.	CRYs- TALLI- ZATION.	MAGNETIC BEFORE OR AFTER HEATING.	USES.
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compound is heated on a carbonized match or charcoal in R. F., a yellow malleable bead is obtained, which dissolves in aqua Gold can be readily detected in its solutions, inasmuch as it is obtained in a metallic state by reducing agents. The well-washed charcoal in O. F. If associated with copper or silver, it must be fused with a large excess of pure metallic lead and subjected to is quite yellow, this is a proof that but little silver is present. It is then to be tested with salt of phosphorus to prove the presence color, the amount of gold will be small, and in order to prove its presence and approximate quantity the globule must be digested this powder or mass be washed and fused with borax on charcoal, it will yield a globule of metallic gold. The chief source is the associated are rare.—Uses.—Used as a money metal, for gilding, for jewelry, and for a vast number of ornamental objects.

Insoluble in any single acid, but readily in nitro-hydrochloric.	Yellow, rarely orange-red, and inclining to silver-white.	Dull metallic.	Like color.	2.5-3	2.5-3	12-20	I.	See under heading GOLD, etc.
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NAME.	COMP. AND PERCENTAGE OF IMPORTANT CONSTITUENT.	GENERAL CHARACTERS AND ASSOCIATIONS.	SPECIFIC BEFORE BLOWPIPE.
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GOLD AND ITS COMPOUNDS.—Continued.

Auriferous Iron Pyrites, etc. (See Pyrite.)	Variable.	Gold is found intimately, but usually in very small quantities, associated with pyrites, but the best opinion alteration. In fact, they are found imbedded in each other, but with no further relation than that they chalcopyrite, marcasite, etc., when associated with gold.	
Sylvanite, etc. (Telluride of Gold.)	(AgAu)Te, Gold, Silver, and variable, sometimes little or no silver present. 24.5% 13.4%	(AgAu)Te, A telluride of gold and silver in which the proportion of gold and silver is nearly equal. Transylvania, California, and Colorado. Gold, <i>Calaverite</i> is a variety in which the proportion of gold to silver is 6 to 1. Silver, <i>Nagyagite</i> , another variety, is a sulpho-telluride of lead and gold and antimony. At Cripple Creek, Colo., very little silver is present, the combination being simple telluride of gold. The associated minerals are usually quartz, pyrites, sometimes fluor-spar, etc., etc.	After long heating gives a yellow malleable metallic globule. On coal fuses to a dark gray globule, depositing at same time a white coating, which in R. F. disappears, tinging flame bluish green.

CHARACTERS.	COLOR.	LUSTRE.	STREAK	FUSIBILITY.	HARDNESS.	SP. GR.	CRYSTALLIZATION.	MAGNETIC BEFORE OR AFTER HEATING.	USES.
TREATMENT WITH ACIDS, ETC.									
is that there is no chemical combination of the two. It occurs in pyrites or attached to pyrites or the oxide resulting from its were deposited together, one on the other. This is also true of the other sulphides, such as galena, zinc blende, arsenopyrite,									
Incompletely soluble in HNO ₃ . Soluble in aqua regia, with separation of chloride of silver. In open glass tube yields a white sublimate of tellurium dioxide which is gray near the assay, and which, when played upon by flame, fuses to transparent drops.									
Steel-gray to silver-white, rarely brass-yellow.									
Metallic, brilliant.									
Steel-gray and like color									
Easily fusible.									
1.5-2									
8									
V.									
See under heading GOLD, etc.									

NAME.	COMP. AND PERCENTAGE OF IMPORTANT CONSTITUENT.	GENERAL CHARACTERS AND ASSOCIATIONS.	SPECIFIC
			BEFORE BLOWPIPE.
Graphite	C.	<p>Resembles molybdenite (<i>q. v.</i>), but differs in being unaffected by the blowpipe and acids, and greatly in specific gravity. The same characters distinguish the granular varieties from any metallic ores they resemble.</p> <p>Usually found in very old crystalline rocks of sedimentary origin in irregularly bedded veins or masses, but is often found as a constituent of mica schist or gneiss, and sometimes of crystalline limestone. Sometimes found disseminated through these rocks as foliated laminae or scales, and occasionally in the older sandstone. Being derived from organic matter, it is naturally found in rocks of an originally sedimentary character, though these are now usually greatly metamorphosed. The so-called vein graphite is usually associated with calcite and quartz. Pyroxene, mica, and apatite are sometimes found with it.</p>	<p>Very soft. Soils the fingers and feels greasy. Absolutely infusible B. B. If held in zinc forceps and dipped into solution of sulphate of copper, becomes quickly covered with copper. At a high temperature burns, but not more easily than diamond, <i>q. v.</i></p>
Halite (Rock Salt) (mas- sive).	NaCl. Chlorine, 39.4%. Sodium, 60.6%.	<p>Crystalline form of common salt. Distinguished by its solubility and saline taste. Cubic crystals. Furnishes the greater part of the supply of salt.</p> <p>Occurs in extensive but irregular beds in many stratified formations usually associated with gypsum, anhydrite, calcite, clays, or sandstone. In Chile often associated with the nitrate of soda deposits. Common salt is often found covering large areas representing the drying up of salt lakes; also as an efflorescence in arid and semi-arid regions, and also in solution forming salt springs or in the water of the ocean and all inland salt seas.</p>	<p>Crackles or decrepitates when heated. Fuses easily, coloring flame a deep yellow.</p>

CHARACTERS.

TREATMENT WITH ACIDS, ETC.

When treated in a platinum spoon with nitre deflagrates, affording carbonate of potassa, which effervesces in acids. Unaffected by acids.

COLOR.	LUSTRE.	STREAK	FUSIBILITY.	HARDNESS.	SP. GR.	CRYSTALLIZATION.	MAGNETIC BEFORE OR AFTER HEATING.
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Iron-black to dark steel-gray.

Metallic, sometimes dull earthy

Black

Infus.

1-2

2-2.2

III.

Uses.

Graphite is extensively employed as a lubricant in machinery, for making refractory crucibles, for stove polish, paints, in the manufacture of lead-pencils, and generally in the manufacture of refractory articles and somewhat in the manufacture of electrical supplies. By far the most part is employed in the manufacture of crucibles, after which comes the consumption for stove polish, for which an inferior grade of mineral suffices. The amount used for lead-pencils is comparatively small, but the best quality is required.

Soluble in 3 parts of water. With nitrate of silver, white precipitate of silver chloride.

Colorless, white, yellow, red, bluish, purple.

Vitreous.

White.

Easily

2.5

2.15

I.

This mineral is the chief source of common salt. It is not considered necessary to mention the manifold uses to which this compound is put.

NAME.	COMP. AND PERCENTAGE OF IMPORTANT CONSTITUENT.	GENERAL CHARACTERS AND ASSOCIATIONS.	SPECIFIC
			BEFORE BLOWPIPE.
Horn-blende (Amphibole).	Essentially bisilicates of various protoxides and sesquioxides. The protoxides may be magnesia, lime, soda, potash, and the protoxides of iron and manganese. The sesquioxides are alumina and the peroxides of iron and manganese.	Numerous compounds, which it is not necessary to mention. Very tough. Compare pyroxene, to which it is closely allied, in composition as well as appearance. Massive (hornblende schist). Chief varieties are <i>tremolite</i> and <i>actinolite</i> , to which when fibrous the name <i>asbestus</i> is often given; also referred to as <i>mountain leather</i> , <i>mountain paper</i> , <i>mountain cork</i> , or <i>mountain wood</i> . (See Asbestos.)	Swells up and fuses with effervescence to a black or grayish glass.
(Common rock constituent.)		Occurs abundantly in the older metamorphic rocks, such as in many crystalline limestones, granites, and schistose rocks. It occurs sparingly in serpentine and igneous rocks.	

HYDROCARBONS.

Compounds of carbon, hydrogen, and oxygen. These compounds are numerous, and form a great variety of economically under their proper heads. For sake of distinguishing between them the various coals are placed in a separate division, although quantities of paraffin, while this can be said of only a few of the coals. While the latter chemically considered possess many

{ a. Solids.	Fixed carbon	A peculiar hard pitchlike material, somewhat resembling coal. Some varieties soften a little in boiling water, and all are but slightly soluble in camphene. Not as fusible or as soluble in benzene or ether as asphaltum, but shows incipient fusion in candle flame. The same may be said of the following varieties, which differ from each other chiefly in the amount of oxygenation which they have undergone, which fact has had an important bearing upon their physical properties. They pass from one into the other by insensible gradations. Albertite is usually extremely brittle, with very distinct conchoidal fracture.
	Albertite.	much higher than in the following. Occurs filling irregular fissures in rocks of the Subcarboniferous or Lower Carboniferous age in Nova Scotia.

CHARACTERS.	COLOR.	LUSTRE.	STREAK	FUSIBILITY.	HARDNESS.	SP. GR.	CRYSTALLIZATION.	MAGNETIC BEFORE OR AFTER HEATING.	USES.
TREATMENT WITH ACIDS, ETC.									
Not acted upon by acids, or only very slightly.	Generally green to black.	Vitreous, silky. Sub-translucent to opaque.	Uncolored or paler than color.	2.5	5.5	3	V.		

important gaseous, liquid, and solid products, the composition and characters of the more prominent among which are stated they are also oxygenated hydrocarbons, one point of difference being that the substances here enumerated generally yield large characteristics in common with, they differ widely in physical and in other respects from, the following less well known varieties:

Some varieties are not at all soluble, others partially soluble in oil of turpentine. Softens a little in boiling water.	Lustrous jet-black.	Brilliant to dull, vitreous.	Black	Imperfect.	1.5	1.09	Amorphous
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NAME.	COMP. AND PERCENTAGE OF IMPORTANT CONSTITUENT.	GENERAL CHARACTERS AND ASSOCIATIONS.	SPECIFIC BEFORE BLOWPIPE.
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HYDROCARBONS.—Continued.

Graham- ite.	More vola- tile mat- ter (illu- minating gas) than in albertite.	Much like albertite, but differs from it in being entirely soluble in camphene; also harder. Melts only imperfectly when heated. Occurrence much the same as the foregoing, in West Virginia.	
Uintahite or Gil- sonite.		Related to albertite, but tougher, with fracture conchoidal, and having very different properties. Fuses easily in candle flame. Occurs in true fissure veins traversing sandstones and shales in much the same manner as the above, in Utah, etc.	
Ozoker- ite.	Simple hy- drocarbon contain- ing no oxygen, a paraffin.	Like wax or spermaceti in consistency. It and kindred substances often referred to as "earthy wax." May be kneaded like wax. Softens in heat of hand. Feels greasy. Melts readily like sealing-wax, but will not adhere to paper unless very hot. Takes impression of the seal. Electrically excited by friction. Under high heat the interior may be drawn into threads. <i>Wurtsilite</i> is a jetlike variety which is sectile, somewhat like gutta-percha, and slightly elastic, but brittle when cold; more elastic if quietly warmed. Fuses readily, but resists the ordinary solvents of bitumen. When warmed becomes more plastic. Occurs with former and related materials in Utah, etc., and, like the former, has probably some connection with the asphalt deposits there. It is also found in Europe with coal or bituminous deposits; also associated with petroleum in sandstone in Galicia, Saxony, etc.	

CHARACTERS. TREATMENT WITH ACIDS, ETC.	COLOR.	LUSTRE.	STREAK	FUSIBILITY.	HARDNESS.	SP. GR.	CRYSTALLIZATION.	MAGNETIC BEFORE OR AFTER HEATING	USES.
Nearly completely soluble in camphene. No action with HCl or HNO ₃ .	Pitch- or jet-black.	Lustrous, brilliant.	Black	Imperfect.	2	1.4	Amorphous		
Soluble in petroleum or warm oil of turpentine. Ether slowly dissolves powder.	Black.	Lustrous.	Rich brown	Easily	2.25	1.06	Amorphous	There is a limited demand for this mineral as well as the two former among the manufacturers of certain grades of carriage-varnish and stove-blacking.	
Soluble in boiling ether or benzene. The dilute solution is highly fluorescent.	White to yellowish brown and darker shades.	Dull, translucent.	Like color.	Melts at 61° C.	Soft.	0.85-0.95	Amorphous	Largely used, especially in Russia, as a substitute for beeswax. The mineral is distilled, and the resulting wax is employed in the manufacture of candles, which are especially adapted for use in high latitudes. Refined ozokerite is used in the manufacture of waxed paper, for the lining of wooden vessels, in the manufacture of varnish and blacking, for adulterating beeswax, for calking ships, for making liniments, plasters, salves, shoemakers' wax, wax ornaments, toy figures, in the manufacture of heavy lubricants where body is requisite, and for any of the thousand or more uses to which beeswax is applicable.	

NAME.	COMP. AND PERCENTAGE OF IMPORTANT CONSTITUENT.	GENERAL CHARACTERS AND ASSOCIATIONS.	SPECIFIC BEFORE BLOWPIPE.
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HYDROCARBONS.—Continued.

b. <i>Solid to semi-liquid.</i>	Mixture of different hydro-carbons, part of which are oxy-genated.	Seems to be the residue after the distillation of the lighter and more volatile oils, being variable in composition. Fusible and inflammable, and burns with bright flame. Is more or less soft, has a bituminous odor, often melts in heat of sun (at 90° to 100°), and flows like wax, then becomes hard on cooling. It varies from tough and somewhat hard material to soft and viscid substances, according to composition and different physical characteristics. It grades insensibly from the solid bitumen into the viscid bitumen, maltha, or mineral tar (pitt asphalts), through which there is a gradation to petroleum. The thin varieties usually bespeak the presence of the "lighter oils," which detract from its value as a paving material. These lighter oils (vaporizable at about 110° or below) are usually, however, sparingly present, while the heavy oils (vaporizable at from 100° to 250°) constitute sometimes as much as 85% of the mass.	
		Principal deposit is the famous pitch lake of Trinidad. There are similar deposits in Venezuela on the mainland. It is, however, widely distributed throughout the United States, either in beds or as impregnating sandstones, shales, and limestones, in Kentucky, Indian Territory, Texas, Utah, etc., largely admixed with extraneous material. Occurs in many places in Europe, but the better variety seems to be associated with limestone, as at Val de Travers. It is a very generally distributed mineral, and is found in many parts of the world. It occurs in many localities where petroleum is found.	
c. <i>Liquid.</i>	Principally composed of members of the paraffin series, with a smaller percentage of olefines. Variable.	"Mineral oil." Density .6 to .85. Of many colors, but usually dark greenish brown. Disagreeable odor. Varies also in consistency from the thin flowing kind into those which are thick and viscous, and thence by insensible gradation into the solid bitumen or asphalt.	
Petro-leum.		Occurs most abundantly in certain sandstone strata underlying the coal measures, as in Pennsylvania, West Virginia, etc. It is also found in limestone in Ohio, where this rock furnishes most of the production afforded by that region. It is not, however, confined to the older strata, but is frequently found in Tertiary strata, as in Russia. The exact origin of petroleum and the other hydrocarbons is unknown, but they are presumed to have had their origin in organic matter (vegetable or animal, or both) which accumulated in the sedimentary material in which these deposits are found. It is found in sedimentary strata of all ages, from Silurian up to Tertiary, in the United States more particularly in Silurian, Devonian, and Subcarboniferous formations. Owing to the nature of its origin, it is not found in association with eruptive rocks.	

CHARACTERS. TREATMENT WITH ACIDS, ETC.	COLOR.	LUSTRE.	STREAK	FUSI- BILITY.	HARD- NESS.	SP. GR.	CRY- STALI- ZATION.	MAGNETIC BEFORE OR AFTER HEATING.	USES.	
In closed tube gives empyreumatic oil, some ammoniacal water, combustible gases, and leaves carbonaceous residue. Does not color potash solution. Powder boiled with ether imparts to it a wine- or brown-red color. Soluble mostly in ether and oil of turpentine, partly in alcohol, but some solid asphalts are not at all soluble in the latter.	Usually black to brownish black.	Dull like black pitch.	Like color.	Melts at 90° to 100° C.	Vari- able.	1-1.8	Amor- phous	By far the greatest consumption of this mineral is for street-paving, but it is also used as a covering for many kinds of wooden, iron, and other constructions, so as to protect them from decay or rust. Used for preparing roofing-felts and for water-		
Soluble in benzene or camphene.	Dark yellow to brown, and nearly black and greenish brown.					0.6-0.9		proof material for coating water-pipes, in mechanical engineering for the foundations of dynamos, steam-hammers, and other machinery where jarring is to be suppressed. It is employed in various forms in naval, military, sanitary, electrical and mining constructions. It is also employed in varnishes, photography, and otherwise.		

employed for a vast number of other purposes. It is used in the production of gas, as an enricher of common coal-gas, and when refined the waste products are employed in the manufacture of the various kinds of aniline dyes, in the manufacture of paraffin candles, and in the manufacture of many salves, etc., used in medicine. Crude petroleum, as well as some of the refined products, is largely used as a lubricant.

NAME.	COMP. AND PERCENTAGE OF IMPORTANT CONSTITUENT.	GENERAL CHARACTERS AND ASSOCIATIONS.	SPECIFIC BEFORE BLOWPIPE.
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HYDROCARBONS.—Continued.

d. CH₄. Volatile, inflammable, etc.
 Gaseous. Variable. Occurs in the same regions and under much the same conditions as petroleum. Being volatile, when in connection with oil, it is usually found above the oil. It is frequently found, however, in oil regions where the well yields nothing but gas.
 Natural Gas.

Infuso-
rial
Earth
(Tripo-
lite). Essentially SiO₂. Some-
times
contains
a small
amount
of water. Earthy or sometimes chalk-like material, largely or entirely made up of silicious skeletons of *diatoms* or with fine spicules of sponges. Feels harsh between the fingers, and glass is scratched when rubbed becomes opaque. Some yellow varieties containing iron oxide turn red. Soluble in hydrofluoric acid than quartz; also soluble in caustic alkalies, but more readily in some varieties than in others.
 Occurs in quite thick stratified deposits, sometimes beneath peat-beds, and is obtained for commerce in the following States: Maine, New Hampshire, Massachusetts, Virginia, California, Nevada, Missouri, etc. It is also found in many other portions of the world, as in Barbadoes, Bohemia, Sicily, Calabria, Greece, the Nicobar Islands, and Nova Scotia. In nearly all of these localities the beds are of Tertiary age. In some regions it is hard and indurated through consolidation due to infiltrating waters. It thus graduates into chert and opal.

CHARACTERS.

TREATMENT WITH ACIDS, ETC.

COLOR.	LUSTRE.	STREAK	FUSIBILITY.	HARDNESS.	SP. GR.	CRYSTALLIZATION.	MAGNETIC BEFORE OR AFTER HEATING.	USES.
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microscopic plants, with it. Infusible, but somewhat more readily

White or grayish, earthy or chalky, but often colored by various impurities.

Earthy.

Whitish or like color.

Infus.

5.5-6.5

1.9-2.3

Amorphous

before
or after
heating.

Besides being used in its natural condition for lighting, it has been extensively employed in the regions where it is found for heating and cooking in residences, and for a time to a large extent it was used in the place of coke in the manufacture and treatment of iron, and in many manufacturing and industrial establishments.

This is used and sold in commerce as a polishing powder under the names "electro-silicon" and "silex." It is also used for making solutions of soluble silica (soda silicate), and for purposes of a cement. Owing to its poor conduction of heat, it has been applied as a protection to steam boilers and pipes. It is sometimes used to give body to soap.

NAME.	COMP. AND PERCENTAGE OF IMPORTANT CONSTITUENT.	GENERAL CHARACTERS AND ASSOCIATIONS.	SPECIFIC BEFORE BLOWPIPE.
Iridium. (Iridos- mine.)	Iridium and Osmium in different proportions, in which the iridium varies from 40% to 70%.	Generally in combination with osmium or platinum or allied metals. Harder than platinum. Usually in foliæ or irregular flattened grains. Slightly malleable to nearly brittle. Hardness varies in proportion to amount of the other softer metals with which it is always alloyed. Usually found in alluvial or gravel deposits (placers) with grains of platinum, gold, chromic iron ore, etc. Small quantities are found in Oregon and elsewhere on the Pacific Coast.	Wholly unaltered B. B. or by fluxes.

IRON AND ITS COMPOUNDS.

With borax in O. F. oxide of iron gives a dark brown-red glass, which becomes pale-yellowish or colorless on cooling; it becomes magnetic when heated with soda on charcoal, and dissolve readily in HCl; sulphide of ammonium gives to their solution a excellent test is to add ferrocyanide of potassium to solution. A pale-blue precipitate indicates ferrous salts, and a dark blue borax or salt of phosphorus bead becomes violet-blue or reddish purple when the R. F. is directed upon it, especially if tin be added, to boil. Set aside. If titanium is present, the solution becomes violet in color. The presence of chromium is also readily

CHARACTERS.	COLOR.	LUSTRE.	STREAK	FUSI-BILITY.	HARD-NESS.	Sp. Gr.	CRYSTAL-LIZATION.	MAGNETIC BEFORE OR AFTER HEATING	Uses.
TREATMENT WITH ACIDS, ETC.	Not attacked by acids, except slightly by heated aqua regia.	Pale steel-gray to tin-white to lead-gray.	Metallic.	Like color.	Infus.	6-7	19-21	III.	Owing to its hardness, its principal use is for the points which are affixed to the nibs of gold pens, and for the knife-edges of fine balances, for the tips of rubber-turning tools, for wire draw-plates, etc. An alloy of pure iridium and pure platinum has been adopted for the standards of weights and measures, on account of its indestructibility and other desirable attributes. In the condition of sponge and oxide it is used in photography and the ceramic art for obtaining a dense black, also by jewellers for obtaining black under white enamel. In all such cases its use is due to its infusibility.

R. F. bottle-green on cooling. With tin the green color is hastened Most of the compounds black precipitate, which is soluble in dilute HCl, distinguishing it from cobalt and nickel. Another precipitate, ferric salts of iron. The presence of titanium may be detected by the fact that the and test made on charcoal. A better test is to add tin to concentrated HCl solution, and continue detected. (See Chromic Iron.)

This metal is put to more manifold and more useful purposes than any other known to man. It is not considered necessary to attempt to enumerate them.

NAME.	COMP. AND PERCENTAGE OF IMPORTANT CONSTITUENT.	GENERAL CHARACTERS AND ASSOCIATIONS.	SPECIFIC
			BEFORE BLOWPIPE.
IRON AND ITS COMPOUNDS.—Continued.			
Magnetite (Magnetic Iron Ore).	Fe ₃ O ₄ .	Easily recognized by streak and strong magnetism, which distinguish it from the following. Very common, hard, compact, and massive ore.	Magnetic before heating, usually strongly, but sometimes only feebly; sometimes having polarity. Reacts for iron. Generally fusible above 5. In O. F. loses its influence upon the magnet.
Hematite Varieties are:	Fe ₂ O ₃ . Iron, 70%.	Scaly, fibrous, and compact, columnar. Sometimes concretionary, reniform, or botryoidal (<i>kidney ore</i>). Red powder, and the magnetism so easily induced in it by R. F., serve to distinguish it. Occurrence much the same as above. Often in great interbedded masses in the older crystalline or metamorphic rocks especially, but is found in rocks of all ages. Like magnetite, it often in the western part of the United States marks the outcrop or oxidized portion of fissure-veins, contact-deposits, isolated pockets in limestone, etc., which contain at greater depths large quantities of pyrites. Often intimately associated with magnetite, as in Michigan, etc.	Heated in R. F. readily becomes magnetic, and if treated with soda on charcoal is reduced to a gray magnetic metallic powder.

CHARACTERS. TREATMENT WITH ACIDS, ETC.	COLOR.	LUSTRE.	STREAK	FUSI- BILITY.	HARD- NESS.	SP. GR.	CRY- SILLI- ZATION.	MAGNETIC BEFORE OR AFTER HEATING.	USES.
Reacts for iron.	Iron-black.	Splen- dent, metal- lic to subme- tallic and dull.	Black	5	5.5- 6.5	5.17	I.	Both.	See under heading IRON, etc.
Reacts for iron.	Dark steel- gray, iron- black to brown-red and reddish varieties.	When crystal- lized, splen- dent. Usually metallic to sub- metallic. Some- times dull.	Cher- ry-red to brown- ish-red.	Infus. or above 5.	5.5- 6.5	4.2- 5.2	III.	After.	When pulverized it is some- times used for polishing metal. When in an earthy condition it is used in the manufacture of crayons, for polishing glass, and as a red paint.

NAME.	COMP. AND PERCENTAGE OF IMPORTANT CONSTITUENT.	GENERAL CHARACTERS AND ASSOCIATIONS.	SPECIFIC BEFORE BLOWPIPE.
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IRON AND ITS COMPOUNDS.—Continued.

(a)	Fe ₂ O ₃ .	Hard, compact, and crystalline. Massive. That from Lake Superior region generally spoken of in commercial language as hard specular, or hard red specular.	Same as above.
Specular.	Iron, 70%.	In interbedded masses in crystalline rocks, as in Michigan, etc. A valuable ore.	
(b)	Fe ₂ O ₃ .	These varieties possess a foliated, scaly, or micaceous structure. This specular schist often resembles called <i>itabirite</i> . Reacts as above B. B. and with acids. Variety of the preceding. Some kinds are soft	
Mica-ceous.	Iron, 70%.	Like the above ores occurs in crystalline and usually schistose rocks. Michigan, etc.	
(c)	Fe ₂ O ₃ .	Hematite in octahedrons, derived, it is supposed, from oxidation of magnetite, with which it is commonly guished by its purple streak. N.B.—Sometimes ore is found giving red streak, yet possessing	
Martite.	Iron, 70%.	to presence of magnetite in the mass. Michigan, etc.	
(d)	Fe ₂ O ₃ .	A soft, earthy variety, but often very pure. Loose and uncompact to semi-consolidated. Often man-	
Soft Hema- tite.	Iron, 70%.	ganiferous. (Abundant and valuable ore. Michigan.) Sub-variety bluish.	

CHARACTERS TREATMENT WITH ACIDS, ETC.	COLOR.	LUSTRE.	STREAK	FUSI- BILITY.	HARD- NESS.	SP. GR.	CRY- STALLI- ZATION.	MAGNETIC BEFORE OR AFTER HEATING.	USES.
Same as above.	Dark steel-gray to reddish-black, reddish, iron-black.	Perfectly metallic. Often splendid.	Red or reddish-brown	Infus. or above 5.	5.5-6.5	5	III.	After.	See under heading IRON, etc.
mica schist, when it is and unctuous.	Light to dark steel-gray.	Splendent metallic.	Reddish.	Infus. or above 5.	5.5-6.5	5	III.	After.	See under heading IRON, etc.
associated. Distinct magnetism, always due	Iron-black to reddish black or bronze tarnish.	Sub-metallic.	Purplish or reddish brown	Infus. or above 5.	6-7	5	I.	After. Sometimes feebly before.	See under heading IRON, etc.
	Dull red, reddish to yellowish brown.	Earthy.	Purplish brownish to reddish	Infus. or above 5.	Variable.	4-5	Amorphous	After.	See under heading IRON, etc.

NAME.	COMP. AND PERCENTAGE OF IMPORTANT CONSTITUENT.	GENERAL CHARACTERS AND ASSOCIATIONS.	SPECIFIC BEFORE BLOWPIPE.
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IRON AND ITS COMPOUNDS.—Continued.

(e) Fossil Ore (Lenticular iron ore), etc.	Fe ₂ O ₃ .	Commonly called fossiliferous red hematite. Oolitic or composed of aggregations of small, flattened, different sizes. Usually contains a large percentage of impurities (lime, clay, sand, etc.). Often includes fossil remains. This variety is both hematite and limonite in character, but more frequently the latter description it affords the characteristic yellowish powder. Another variety is <i>argillaceous stone</i> , which is hard, brownish black to reddish brown or dull red, submetallic to unmetallic and has a red streak, which is thus easily distinguished from the clay iron-stones of the species brown clay iron-stone (limonite) stone (siderite).	Often an admixture of hematite and limonite. Compact, looking much like compact red shale. (Virginia, impure.)
	Iron, 70%.		
(f) Red Shale Ore.	Fe ₂ O ₃ .	Often an admixture of hematite and limonite. Compact, looking much like compact red shale. (Virginia, impure.)	Often an admixture of hematite and limonite. Compact, looking much like compact red shale. (Virginia, impure.)
	Iron, 70%.		
(g) Red Ochre.	Fe ₂ O ₃ .	Earthy or pulverulent form (used for pigments). Soft and earthy. Often associated with the above, mixed with more or less clay.	Heated in closed tube flies to pieces and yields water.
	Iron, 70%.		
Turgite.	Fe ₂ H ₂ O ₃ .	Often associated with limonite, for which it is frequently mistaken, but it is harder, has a different streak, and decrepitates in closed tube. Often constitutes an exterior layer of limonite. When botryoidal has much the same smooth lustrous surface. Supposed to be intermediate stage in alteration of limonite to hematite. Another intermediate variety less common than this is <i>goethite</i> , containing 62.9% of iron and 10.1% of water. Found with both hematite and limonite. Liver-brown color, reddish streak like limonite. The so-called <i>velvet ore</i> is frequently of this variety.	Heated in closed tube flies to pieces and yields water.
	Iron, 66.2%.		
		Occurs with other ores of iron, especially in the older beds, and in intimate association with limonite.	

CHARACTERS. TREATMENT WITH ACIDS, ETC.	COLOR.	LUSTRE.	STREAK	FUSI- BILITY.	HARD- NESS.	SP. GR.	CRYSTAL- LIZATION.	MAGNETIC BEFORE OR AFTER HEATING.	USES.
concretionary grains of fossils or composed of former. When of the hematite or clay iron-streak. This species and ordinary clay iron-	Reddish to brownish.	Dull.	Reddish brown to purplish red.	Infus. or above 5.	4.5-6	5	III(?)	After.	See under heading IRON, etc
etc.) Generally very	Reddish to brownish.	Earthy and dull.	Reddish to brownish.	Infus. or above 5.	4.5-6	5	III(?)	After.	See under heading IRON, etc
Usually impure, being	Earthy red.								Often used as paint.
Like hematite,	Reddish black, dark red to bright red.	Submetallic, satin-like, dull, earthy.	Red.	5	5-6	4.14	Amorphous	After.	See under heading IRON, etc

NAME.	COMP. AND PERCENTAGE OF IMPORTANT CONSTITUENT.	GENERAL CHARACTERS AND ASSOCIATIONS.	SPECIFIC BEFORE BLOWPIPE.
		IRON AND ITS COMPOUNDS.—Continued.	
Limonite (Brown Hema- tite). <i>Varie- ties are:</i>	$2\text{Fe}_2\text{O}_3 \cdot 3\text{H}_2\text{O}$. Iron, 59.8%.	Compact, often dense when pure. Botryoidal, stalactitic with compact fibrous structure within, but also massive, etc. Not crystalline. Tendency to form acicular, sometimes stalactitic concretionary masses, with long needle-like fibres radiating from common centre; but generally amorphous. Common ore. Occurs in rocks of all ages. It has resulted, it is supposed, from the decomposition of other iron-bearing rocks or minerals. This is shown by the stalactitic and other forms in which it occurs. Like hematite and magnetite it frequently marks the outcroppings of fissure-veins, having been produced by the decomposition of the original pyrites or siderite in the vein.	With difficulty fusible to a magnetic mass. Some varieties leave a silicious skeleton on salt of phosphorus bead.
Bog Iron Ore.	$2\text{Fe}_2\text{O}_3 \cdot 3\text{H}_2\text{O}$. Iron, 59.8%.	Simply a vesicular and generally impure variety of the above. Recognized by its comparatively light weight, yellow color, and loose or porous texture. Often petrifying wood, leaves, etc. Usually superficial, and occurs in swampy places containing vegetation — often decomposing — into which places have flowed waters containing iron in solution, the iron having been precipitated by the presence of the organic matter.	Gives all the reactions of the above.
Yellow Ochre.	$2\text{Fe}_2\text{O}_3 \cdot 3\text{H}_2\text{O}$. Iron, 59.8%.	Earthy or pulverulent form of above. Earthy, brownish, yellow to ochre-yellow. Usually impure, being mixed with more or less clay, sand, etc.	

CHARACTERS. TREATMENT WITH ACIDS, ETC.	COLOR.	LUSTRE.	STREAK	FUSI- BILITY.	HARD- NESS.	Sp. Gr.	Crys- tallization.	MAGNETIC BEFORE OR AFTER HEATING.	USES.
Reacts for iron. Yields much water (of which it contains 14.5% and often more) in closed tube. Soluble, but with difficulty, in HCl, leaving frequently a silicious residue.	Brown, various shades, yellow, black. Never bright.	Dull, earthy to sub-metallic. Sometimes silky.	Brown-yellow to yellow.	5	5-5.5	3.6-4	Amorphous	After.	Limonite is also used, like hematite, for polishing metallic buttons and other articles. When earthy it is a common material for paint.
As above.	Yellowish to brownish.	Dull.	Brown-yellow to yellow.	5	4-4.5	Variable.	Amorphous	After.	See under heading IRON, etc.
like "Red Ochre,"								After.	Used as a paint or in paint-mixtures.

NAME.	COMP. AND PERCENTAGE OF IMPORTANT CONSTITUENT.	GENERAL CHARACTERS AND ASSOCIATIONS.	SPECIFIC
			BEFORE BLOWPIPE.
IRON AND ITS COMPOUNDS.—Continued.			
Siderite (Spathic Iron Ore) or Iron Carbon- ate. <i>Varieties</i> are:	FeCO ₃ . Iron, 48.2%.	Often crystalline. Worked extensively in Europe. Occurs in many series of stratified rocks from the oldest to the youngest. Frequently found as stratified deposits in connection with coal formations, but it is also found in large irregular deposits in limestone. Less frequently it is found forming part of the frilling of fissure-veins, when it is usually crystallized and associated with the metallic ores. In the former cases its occurrence is usually massive, and as such it is an important ore of iron. <i>Ankerite</i> , crystallized dolomitic variety.	Becomes magnetic upon heating R. F. With borax, gives reaction for iron. Decrepitates in closed tube and gives off CO ₂ , blackens and becomes magnetic.
Clay Iron- stone,	FeCO ₃ .	Name commonly given to compact, earthy, or stony kinds of above, which are rendered impure by an sand. In many formations, especially among the coal measures (England, etc.). Fracture finely granular. gives out an argillaceous odor when breathed upon. Sometimes as flattened spheroidal concretionary or oolitic; also granular to massive. Sometimes, when reddish in color, consists of impure hematite, of impure limonite; when unoxidized, however, is simply a more or less impure iron carbonate.	
	Same, but very va- riable, ac- cording to impuri- ties.	This variety of the above occurs in rocks of all ages, the specular variety (argillaceous hematite, see fossil ore) being mostly confined to the older rocks. Also described as being the result of igneous action about some volcanoes, as at Vesuvius. (Dana.)	
Black Band Ore. Subva- riety of above.	Same, but very va- riable, ac- cording to impuri- ties.	A common variety of above, occurring in coal measures, and containing sometimes as much as 25% to 30% of A valuable ore in England, where the ore sometimes contains enough carbonaceous matter to effect the lic state without addition of anything except limestone.	

CHARACTERS. TREATMENT WITH ACIDS, ETC.	COLOR.	LUSTRE.	STREAK	FUSI- BILITY.	HARD- NESS.	SP. GR.	CRYB- TALLI- ZATION.	MAGNETIC BEFORE OR AFTER HEATING.	Uses.
Soluble in heated HCl, with effervescence (CO_2), which is also given off when the ore is heated in closed tube.	Ash, yellowish and brownish gray to brown-red. Sometimes green and white.	Vitreous, inclining to pearly.	White or uncolored except by impurities.	4.5	3.5-4	3.8	III.	After.	See under heading IRON, etc.
admixture of clay or Easily scratched, and masses of various sizes, or, if brown or yellow,	Yellowish brown to reddish gray.	Dull.	Whitish or grayish.	4.5	3-7	3.4	Amorphous	After.	See under heading IRON, etc.
carbonaceous matter. reduction to the metal-	Grayish black.	Earthy, dull.	Dark gray, etc.	?	3.5	3	Amorphous	After.	See under heading IRON, etc.

NAME.	COMP. AND PERCENTAGE OF IMPORTANT CONSTITUENT.	GENERAL CHARACTERS AND ASSOCIATIONS.	SPECIFIC
			BEFORE BLOWPIPE.
IRON AND ITS COMPOUNDS.—Continued.			
Titanic Iron Ore (Ilmenite or Menacanite).	(TiFe_2O_5). Variable. If normal, Titanium, 31.6%. Iron, 36.8%.	A hematite in which part of the iron is replaced by titanium. The presence of titanium is highly prejudicial to the value of any iron ore and, unless the quantity is very minute, renders it worthless as an ore of iron. Occurs in massive beds in gneiss and other crystalline rocks, also disseminated through these rocks and as iron-sands (iserine). Frequently associated with magnetite.	Feebly magnetic. To borax or salt of phosphorus bead imparts an intense brown-red color in R. F., which, if tin be added, changes to violet red.
Chromic Iron.	(Chromite.)	See Chromium and its Compounds.	
Iron Pyrites. Varieties:	FeS ₂ . Iron, 46.6%. Sulphur, 53.4%.	Common pyrites. Distinguished from copper pyrites by its superior hardness and paler color. Cubes with striated surfaces, striae at right angles to one another. Brittle with conchoidal uneven fracture. Common source of sulphuric acid and often auriferous. Occurs abundantly in rocks of all ages, frequently disseminated through them, from the oldest crystalline rocks to the most recent alluvial deposits. A very common mineral in fissure-veins and contact-deposits. It is very frequently associated with such minerals as quartz, galena, blende, copper pyrites, etc., etc.	Gives only reaction for iron. Gives off sulphur B. B. on charcoal, burning with a blue flame.
Marcasite (Cocks-comb Pyrites); (White Iron Pyrites).	FeS ₂ . Iron, 46.6%. Sulphur, 53.4%.	Same as above, but of different crystalline form. Sometimes called capillary pyrites, but this term properly applies to sulphide of nickel (millerite). Associations the same as above.	Sometimes contains little arsenic. More liable to decomposition than ordinary pyrites.

CHARACTERS. TREATMENT WITH ACIDS, ETC.	COLOR.	LUSTRE.	STREAK	FUSI- BILITY.	HARD- NESS.	SP. GR.	CRY- STALLI- ZATION.	MAGNETIC BEFORE OR AFTER HEATING.	USES.
Partially dissolved in HCl. Concentrated solution boiled with tinfoil gradually assumes a violet color.	Iron-black.	Sub-metallic.	Sub-metallic, with black or brown-red powder	Infus.	5-6	4.5-5	III.	Both.	See under heading IRON, etc.
When heated in closed tube gives off sulphur and yields a magnetic residue. But slightly affected by HCl. HNO ₃ dissolves it, leaving residue of sulphur.	Very pale, brass-like, yellow.	Splendid, metallic to glistening, nearly uniform	Brown-black to greenish-black.	Easily	6-6.5	4.9	I.	After.	Large amounts of sulphuric acid and sulphur are prepared from pyrites, though native sulphur (<i>q. v.</i>) is also very largely used for the production of sulphuric acid. It would be difficult to overestimate the commercial importance of the latter.
Same as above.	Pale-yellow, bronze, to white. Color deepens on exposure.	Metallic.	Blackish gray to brownish black.	Easily	6-6.5	4.8	IV.	After.	Used for the same purposes as ordinary pyrites, and to a small extent in 'jewelry.'

NAME.	COMP. AND PERCENTAGE OF IMPORTANT CONSTITUENT.	GENERAL CHARACTERS AND ASSOCIATIONS.	SPECIFIC
			BEFORE BLOWPIPE.
IRON AND ITS COMPOUNDS.—Continued.			
Magnetic Iron Py- rites (Pyrrho- site).	Fe ₃ S ₈ . Iron, 60.4%. Sulphur, 39.5%.	Like common pyrites, but magnetic, and different crystallization. Often contains nickel. Tarnishes quickly. Associations the same as the foregoing.	Magnetic before fusion chief characteristic, but variable in this. In R. F. fuses to black magnetic mass. In O. F. converted into red oxide.
Franklin- ite	(FeZnMn) + (Fe,Mn ₂)O ₄	Resembles magnetite, but is of a more decided black color, and different streak. Usually feebly magnetic. (See also Zinc Ores.) Its chief value consists in the zinc which it contains.	On charcoal a faint zinc coating is obtained with R. F. A soda mixture in outer flame colored green by manganese. With borax reacts for manganese and iron.
Kaolin or Kaolinite (China- clay).	Al ₂ O ₃ , 2SiO ₂ + 2H ₂ O. Silica, 46.5%. Alumina, 39.5%.	Found associated with red oxide of zinc and garnet in granular metamorphic limestone, also with silicate of zinc. Restricted to a few localities near Franklin, N. J. The soapy feeling distinguishes the clay, consisting of it or containing much of it. The unctuous and plastic character is owing to presence of kaolinite. Decomposition of feldspar yields it, etc. (See Dana's <i>Min.</i> , p. 686.) Soft, clay-like, mealy, or compact. Often occurs in the form of scales in connection with the iron ores of the coal formation, also accompanying diaspore and emery or corundum. Nearly always a product of the alteration of feldspar, and therefore associated with feldspathic rocks, usually granite. Has frequently to be separated from grains of quartz, with which it is associated before it is fit for use.	A blue color when moistened with cobalt nitrate (Al). Yields water.

CHARACTERS. TREATMENT WITH ACIDS, ETC.	COLOR.	LUSTRE.	STREAK	FUSI- BILITY.	HARD- NESS.	SP. GR.	CRY- STALLI- ZATION.	MAGNETIC BEFORE OR AFTER HEATING.	USES.
But little sulphur in closed tube. Decomposed by HCl with evolution of hydrogen sulphide.	Bronze-yellow to copper-red.	Metallic.	Black-gray.	Easily	3.5-4.5	4.5	III.	Both.	Like ordinary pyrites, used for making green vitriol and sulphuric acid.
Soluble in HCl, with evolution of chlorine in small quantities.	Iron-black.	Metallic to dull.	Dark red-dish brown to black.	Infus.	6	5.15	I.	Both.	
Insoluble in acids. Yields water in closed tube. Water = 14%. Boiled with concentrated sulphuric acid the alumina is dissolved, leaving the finely-divided silica behind.	White, gray, yellow, and brown to bluish.	Pearly to dull, earthy.	Earthy, dull.	Infus.	2-2.5	2.6	V.		The purest form is largely used in making the finest porcelain, and also for giving body and weight to paper. Some impure and white clays are used for stone-ware, fire-bricks, retorts for gas-works, stove-pipes, etc., etc. Also used in calico-bleaching, and to a small extent in the manufacture of alum, artificial ultramarine, and some other chemical products. (See Fire-clay.)

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BEFORE BLOWPIPE.

LEAD AND ITS COMPOUNDS.

They are easily fusible. With borax bead and with soda, and often alone, on charcoal a malleable bead may be coating is faintly bluish white when cold. When S and KI are added there is a greenish-yellow coating far from assay. Sublimes is nearly insoluble in water and dilute acids. Heated in open tube, white smoke and a non-volatile fusible sublimate is deposited characteristic coating will be produced on the coal. But sulphides, arsenides, etc., of lead must be treated in O. F. to produce the Assay, Appendix.)—USES.—*Perhaps the largest use of lead is in the manufacture of the white lead of commerce (carbonate of lead) metallurgical processes, as an alloy, e.g., with antimony in the manufacture of anti-friction metals and type-metal, with tin in the manu-*

Galena (Galenite).	PbS.	Easily recognized by the characteristic cubical cleavage which is very easily obtained, or granular structure when massive, its color, great weight, and softness. It is the chief ore of lead, and is widely distributed, being very frequently associated with other metallic sulphides, such as pyrite, chalcopyrite, arsenopyrite, blende, etc., etc. It occurs in veins, the gangue of which is either quartz, calcite, barite, or fluor-spar, in granite, and nearly all varieties of rocks, but the larger deposits are usually found either in veins or in pockets, often of great size, in limestone strata. Very frequently contains considerable percentages of silver, and less frequently of gold.	With soda on coal decrepitates, covers the coal yellow, and yields lead globule.
	Lead, 86.6%.		
Cerussite (Lead Carbonate).	PbCO ₃ .	Its brittleness and weight are distinguishing characteristics. <i>NOTE.</i> —The above two ores often contain silver, <i>g. v.</i>	Yields lead alone on charcoal when heated carefully. In closed tube decrepitates, turns yellow, then a dark red, and returns to yellow on cooling.
	Lead, 83.5%.	Usually found in the superficial portions of deposits of galena, to the alteration of which it owes its origin.	

CHARACTERS.

TREATMENT WITH ACIDS, ETC.	COLOR.	LUSTRE.	STREAK	FUSIBILITY.	HARDNESS.	SP. GR.	CRYSTALLIZATION.	MAGNETIC BEFORE OR AFTER HEATING.	USES.
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obtained. Readily recognized by characteristic lemon or sulphur-yellow coating near assay when cold; red when hot. The outer readily. Volatile, tinging flame azure-blue. In nitric acid solution of salts of lead sulphuric acid gives a white precipitate, which on under side of tube. Oxides, carbonates, etc., may be reduced to the metallic state by heating in R. F. with soda, and the metal. Metallic lead obtained as above may be cupelled for silver on charcoal, or, better, on a bone-ash cupel. See B. B. Silver for use in paint. It is also largely made into pipes, sheet-lead, bullets, and shot; also extensively used as a flux in smelting and fixture of solder, etc., and in the manufacture of certain kinds of glass, etc.

Easily soluble in strong nitric acid, with separation of sulphur and the formation of lead sulphate.	Lead-gray.	Splendent, metallic.	Lead-gray.	I	2.5	7.5	I.	When ground to an impalpable powder and mixed in water with clay it is sometimes employed for glazing common stoneware, the earthen vessel being dipped into this liquid and then baked.
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Dissolves readily, with effervescence, in dilute HNO ₃ . With HCl leaves a white residue of lead chloride, which is soluble in hot water.	White, yellowish, or gray or grayish black. When containing copper, tinged blue or green.	Adamantine, vitreous, resinous to pearly.	Uncolored.	Easily	3.5	6.4	IV.	See under heading LEAD, etc.
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NAME.	COMP. AND PERCENTAGE OF IMPORTANT CONSTITUENT.	GENERAL CHARACTERS AND ASSOCIATIONS.	SPECIFIC BEFORE BLOWPIPE.
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MAGNESIUM AND ITS COMPOUNDS.

These afford a clear rose-red or pink color with cobalt nitrate after long heating. This distinguishes it from no precipitate in dilute HCl solution. The fact that the precipitate from magnesia is soluble in water, while that from calcium is signalling. It is also used in refining metals to reduce the metallic oxides contained in them, owing to its great affinity for oxygen. agent, on account of the amount of magnesia which they contain, as, owing to their constitution, they have the property of attracting the phosphorus with it, and does not remain in the resulting pig iron, as it would otherwise do.

(a) Chlorites (Common rock constitu- ents, mas- sive).	Variable.	Name of a group of minerals very closely allied, which are hydrated silicates of aluminum with ferrous iron and magnesium. Sometimes thin foliated like mica, but often granular, massive. Texture granular. Enter very largely into composition of schistose and slaty rocks. Chloritic schists and all their minerals are characterized by the green color which "is common with silicates in which ferrous iron is prominent" (Dana). It occurs often in chloritic and in many rocks as an alteration product, and associated with magnetic hornblende and tourmaline. Often enveloped in quartz.	
	H ₄ Mg ₃ Si ₂ O ₁₀ .	Usually compact, massive, also finely granular. It is a metamorphic rock, the unaltered form being either sedimentary (e.g., limestone) or igneous (e.g., peridotite) in origin, but most serpentine are altered peridotites. Rarely fibrous. Easily scratched or even cut with a knife. Smooth and a little greasy to feel. Hydrated silicate of magnesia. The variety chrysotile or bostonite is fibrous, and is largely mined as asbestos, q. v.	Becomes brownish red B. B., and gives off water in closed tube.
	Magnesia 43%	Often in great dikes—even composing mountain masses—associated often with metamorphosed limestone, hornblende, slate, diallage rock, and greenstone. Certain metallic oxides are frequently found in connection with it, such as those of iron, nickel, and chromium.	
	Silica, 44.1%		

CHARACTERS.	COLOR.	LUSTRE.	STREAK	FUSI- BILITY.	HARD- NESS.	SP. GR.	CRY- STALLI- ZATION.	MAGNETIC BEFORE OR AFTER HEATING.	USES.
TREATMENT WITH ACIDS, ETC.									
alumina. Distinguished from strontia and baryta by different flame-colors, and in the wet way by the fact that sulphuric acid gives not, suffices to distinguish it from the latter, etc.— <u>USES.</u> —The metal is chiefly used as an illuminant in photography and Bricks made of magnesian limestone (see dolomite) or magnesite, are employed in the steel industry as a desulphurising and dephosphorising phorus contained in the iron ore while the ore is being reduced; the phosphorus in consequence becomes entangled in the slag and goes off									
Yields considerable water in glass tube, which distinguishes it from talc, while its granular texture is sufficient to separate it from serpentine. Decomposed in sulphuric acid.	Dark olive-green, grass-green to gray-green, etc.	Pearly, opaque to partly translucent.	Un-colored, greenish.	Infus.	1-6	1.85	V.	See under heading MAGNESIUM, etc.	
Decomposed by H_2SO_4 and HCl , leaving residue of silica. From chrysotile the silica is left in fine fibres. This fact serves to distinguish the serpentine varieties from true asbestos, <i>q. v.</i>	Pale green to greenish black. Sometimes mottled.	Weak resinous, inclining to greasy.	White	Infus.	2-4	2.5	V.	Extensively used in ornamental and architectural work, though whole buildings are sometimes made of this stone. The finer varieties, when cut and polished for ornamental purposes, are sometimes termed marble.	

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GENERAL CHARACTERS AND ASSOCIATIONS.

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BEFORE BLOWPIPE.

MAGNESIUM AND ITS COMPOUNDS.—Continued.

(c)	$H_2Mg_3Si_4O_{12}$	When foliated the foliae are not elastic. Very soft, scratched by the finger-nail. <i>Potstone</i> , ordinary soapstone more or less impure, which is coarse, granular, and is gray, grayish, or brown-gray in color. Also fine granular, e.g., French chalk.	Exfoliates before blowpipe. Moisted with cobalt solution and heated assumes a pale-red color.
Talc (Soap- stone or Steatite). (Massive or rock constitu- ent.)	Magnesia, 31.7% Silica, 63.5%	Constitutes extensive beds in some regions. Also occurs in small quantities in many rocks. Frequently associated with serpentine, talcose or chloritic schists, and dolomite, and contains crystals of a number of other minerals.	
Mag- nesite (Mas- sive).	$MgCO_3$.	White and like calcite in appearance, but often occurring massive, Infusible. and looking like unglazed porcelain.	
	Magnesia, 47.6% CO_2 = 52.4%	This mineral forms quite extensive beds in Canada and in Greece, and occurs in connection with serpentine, talcose schists and other magnesian rocks, also gypsum, and is usually associated with the magnesium minerals, steatite, serpentine, and dolomite. Also found in serpentine, or so admixed with the serpentine as to form a variety of verd-antique marble.	

CHARACTERS. TREATMENT WITH ACIDS, ETC.	COLOR.	LUSTRE.	STREAK	FUSI- BILITY.	HARD- NESS.	SP. GR.	CRYs- TALLI- ZATION.	MAGNETIC BEFORE OR AFTER HEATING.	USES.	
Not acted upon by acids. In closed tube gives a little water, but not till highly heated.	White, apple to dark green, brown, grass- and black-green when impure.	Pearly	White or lighter than color.	Infus. or above	1-1.5	2.7	IV. or V.	Steatite or soapstone is simply a massive form of talc, and is applied to a great variety of purposes, but chiefly to the manufacture of fire-brick, laundry, bath, and chemical tubs, hearthstones, mantels, pencils (French chalk), cooking-pots, griddles, etc. It is carved into many objects, both useful and ornamental. When ground it is used as polish in the composition of mineral paint, in the manufacture of machinery lubricants, for skin and leather dressing, and as an adulterant for soap, for removing grease from cloth, etc. If the powder be exceedingly fine, it has the property of clinging to metal and stone with great tenacity, and makes the finish which protects their surfaces from the weather. It is said to be used with excellent results for heating-stoves. (See <i>Mineral Industry</i> , vol. 2.) The principal use of fibrous talc is in filling and weighting paper, to which it gives strength, weight, durability, and finish. Being insoluble and perfectly harmless when taken into the system, it is used quite extensively as an adulterant in medicines. It is also largely mixed with cheaper kinds of soap, and forms the basis of numerous fire- and water-proof paints and plasters.		
Concentrated solution (hot HCl) gives no precipitate with H_2SO_4 . Compare dolomite, which gives a precipitate. Dissolves entirely in H_2SO_4 ; the other only partially, but, like it, it effervesces with hot HCl, but not with cold.	White, yellow, gray, brown, green.	Vitreous, silky.	White	Infus.	3.5-4.5	3.12	III.	Besides being used for hearths in the "Basic" processes in manufacturing steel as described, it is used quite largely as a bleaching agent in the manufacture of paper from wood-pulp and in the construction of portions of fire-proof buildings. It is also used in the manufacture of Epsom salts (sulphate of magnesia) and for other chemical purposes.		

NAME.
COMP. AND
PERCENTAGE
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GENERAL CHARACTERS AND ASSOCIATIONS.

SPECIFIC

BEFORE BLOWPIPE.

MANGANESE AND ITS COMPOUNDS.

These are readily recognized by the characteristic amethystine color oxide of manganese imparts to beads of borax and salt when cold. With salt of phosphorus, brown-violet when hot, pale-red violet when cold. Do not confuse with the pale violet bead opaque. With soda in O. F. on platinum wire, or, preferably, platinum foil, the color is green or bluish green. Most varieties brown hematite (limonite) and less often with varieties of red hematite or magnetite.—USES.—Over nine tenths of the used in the manufacture of steel, since manganese imparts to the steel not only hardness, but a high degree of toughness and durability. It only the very pure ores are used.

Pyrolu-	MnO ₂ .	The common ore. Soft and soils fingers. Distinguished by its color, softness, etc. Nodular and in layers. Compact to unconsolidated, etc.	Gives manganese reaction.
Manga-	nese, 63.2%	Usually occurs in connection with psilomelane, both crystallized and massive. Often in connection with limonite, both being secondary minerals due to the leaching of the rock containing manganese and iron.	
Psilome-	Variable.	Usually harder than the foregoing, with which it is often associated. Usually more or less admixed with barium and potassium, especially the former. Compact and usually smooth. Nodular, botryoidal, and mammillary, massive and stalactitic. Tendency, like limonite, to acicular concretionary forms. Much resembles above, except that it affords water, and is much harder and contains less manganese. Like the above, often associated with limonite in segregated masses in clay due to the decomposition of limestones and other rocks containing manganese and iron.	Reacts for manganese. Generally gives barium flame, yellowish green when heated in forceps.

CHARACTERS. TREATMENT WITH ACIDS, ETC.	COLOR.	LUSTRE.	STREAK	FUSI- BILITY.	HARD- NESS.	SP. GR.	CRVS- TALLI- ZATION.	MAGNETIC BEFORE OR AFTER HEATING.	Uses.
<p>of phosphorus in O. F.; colorless in R. F. With borax the color becomes violet, amethystine, or purple when hot, amethystine color imparted to beads by presence of titanic acid, which only appears on heating in R. F. Too large a quantity renders are soluble in hydrochloric acid with evolution of chlorine. The oxides are frequently associated with ores of iron, especially manganese that is produced is used in the manufacture of the alloys of iron and manganese, known as ferromanganese or spiegeleisen, is used to a small extent in bleaching, and also in calico-printing, dyeing, and to give a violet color to glass and pottery, for which purposes</p>									
HCl dissolves it, with evolution of chlorine. No water in closed tube.	Iron-black, dark steel-gray to bluish.	Metallic, sub-metallic.	Black, bluish black. Sometimes shining.	Infus.	2.5	4.82	IV.		See under heading MANGANESE, etc.
In HCl solution sulphuric acid yields white precipitate of sulphate of baryta. Yields much water in closed tube.	Iron-black to dark steel-gray.	Submetallic.	Blackish to brown-black. Sometimes shining.	Infus.	5-6	4.2	Amorphous		See under heading MANGANESE, etc.

NAME.	COMP. AND PERCENTAGE OF IMPORTANT CONSTITUENT.	GENERAL CHARACTERS AND ASSOCIATIONS.	SPECIFIC BEFORE BLOWPIPE.
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MANGANESE AND ITS COMPOUNDS.—Continued.

Braun- ite.	$3\text{Mn}_2\text{O}_3$ + MnSiO_3 . Sometimes Mn_3O_4 .	Massive, and often associated with the above species.	Reacts for manganese.
Manga- nite.	Manganese, 63.6%.		
	Mn_3O_4 . H_2O .	Prismatic cleavage, sometimes perfect. Brittle. Comparatively rare. By loss of water it changes into pyrolusite, braunite, or hausmannite.	Reacts for manganese
Haus- mannite.	Manga- nese, 62.4%.	Occurs sometimes in veins traversing porphyry and associated with calcite and barite.	
Wad (Bog Manga- nese).	Mn_3O_4 .	Rare and unimportant. Sometimes occurs in porphyry along with other manganese ores.	Reacts for manganese.
	$\text{H}_2\text{Mn}_3\text{O}_4$.	Earthy variety and common, but of small importance. Soft, and soils fingers. Usually mixed with silica, baryta, alumina, and iron oxide, sometimes nickel and cobalt. Light in weight. Rarely hard in reniform masses.	Reacts for manganese.
Occurs as a marsh deposit, and is the result of the decompositions of the other ores. Sometimes contains oxide of cobalt as well as oxide of copper. Sometimes also contains oxide of nickel besides the other two, with iron, lead, and sulphur. Usually contains from 10% to 25% water. Can hardly be regarded as distinct mineral species.			

CHARACTERS. TREATMENT WITH ACIDS, ETC.	COLOR.	LUSTRE.	STREAK	FUSI- BILITY.	HARD- NESS.	SP. GR.	CRY- S- TALLI- ZATION.	MAGNETIC BEFORE OR AFTER HEATING.	USES.
Dissolves in HCl, etc., leaving a residue of gelatinous or flocculent silica.	Dark brown-black to steel-gray.	Submetallic.	Same as color.	Infus.	6.5	4.7	II.		See under heading MANGANESE, etc.
In closed tube yields much water, and in this differs from the following. Otherwise like the above.	Dark steel-gray to iron-black.	Submetallic.	Reddish or tar-nished brown to black.	Infus.	4	4.3	IV.		See under heading MANGANESE, etc.
Gives no water in closed tube.	Brown-black.	Submetallic.	Chestnut-brown.	Infus.	5-5.5	4.7	II.		See under heading MANGANESE, etc.
Gives much water in closed tube.	Dove-gray, bluish black, brown to black.	Earthy, dull.	Reddish brown.	Infus.	Soft to rarely 6.		Amorphous		Sometimes used for bleaching and for umber paint.

NAME.	COMP. AND PERCENTAGE OF IMPORTANT CONSTITUENT.	GENERAL CHARACTERS AND ASSOCIATIONS.	SPECIFIC BEFORE BLOWPIPE.
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MANGANESE AND ITS COMPOUNDS.—Continued.

Rhodo-chrosite (Carbonate of Manganese). (Dialomite.)	MnCO ₃ . 47.8%.	Manganspath. Usually pink or rose-red color. Often calciferous, ferriferous, and sometimes zinciferous. Occurs in veins with other metallic ores, such as those of silver, lead, or copper, or associated with other ores of manganese. Sometimes in stratified or bedded masses. The above oxide ores are in some cases resultant from the oxidation of original carbonate ore. It is quite largely mined in France, but is roasted and thus converted into the commercial oxide before being shipped.	Changes color to gray or brown or black. Decrepitates strongly and gives manganese reaction. Infusible.
Rhodosite (Manganese Spar). (Silicate of manganese.) Common vein-stone.	MnSiO ₃ . 41.9%.	Manganese Spar. Often dark brown or black on surface, "through strong tendency of manganese protoxide to pass to a higher state of oxidation." Somewhat resembles red feldspar, but readily distinguished by its behavior B. B. and with acids. On exposure to air oxidizes rapidly, the outcrop of many metalliferous veins appearing black in consequence. Frequently found in the western United States in fissure veins and similar deposits in connection with and as the gangue of the ores of silver, lead, gold, copper, etc.	Fuses quietly at 3. Gives manganese reaction. When heated becomes dark brown.

MERCURY AND ITS COMPOUNDS.

Mercury, or quicksilver, and its amalgams volatilize on charcoal, but give a sublimate of metallic mercury when heated in brushed together with a feather, etc. When a gray sublimate is obtained without distinct metallic globules, the part of the tube case mercury exists in so small a quantity that the sublimed metal is not perceptible, it may be detected by inserting a piece of gold, giving it a white color. The ores follow.

CHARACTERS.	COLOR.	LUSTRE.	STREAK	FUSIBILITY.	HARDNESS.	SP. GR.	CRYSTALLIZATION.	MAGNETIC BEFORE OR AFTER HEATING.	USES.
TREATMENT WITH ACIDS, ETC.									
Soluble in heated HCl, with effervescence. On exposure to air changes to brown or bright rose-red; varieties become paler.	Rose-red, yellowish, gray, brown, fawn color, and deep red.	Vitreous, pearly.	White	Infus.	4	3.5	III.		See under heading MANGANESE, etc.
Slightly attacked by HCl. Does not effervesce like preceding unless admixture of CaCO ₃ is present. In powder partially dissolves in HCl, the residue becoming white.	Rose-red to brown.	Vitreous.	Un-colored.	2.5-3	6	3.6	VI.		See under heading MANGANESE, etc.

closed tube with or without soda; best with soda. The metal condenses above assay in globules on the tube. These may be coated with it is cut off and boiled in a test-tube with a little dilute HCl. By this treatment mercury collects in shining globules. In gold-leaf, held on end of iron wire, into the tube just above assay. On heating, the mercury is volatilized and unites with the

NAME.	COMP. AND PERCENTAGE OF IMPORTANT CONSTITUENT.	GENERAL CHARACTERS AND ASSOCIATIONS.	SPECIFIC
			BEFORE BLOWPIPE.
MERCURY AND ITS COMPOUNDS.—Continued.			
Native.	Hg.	Occurs in small liquid globules, probably resultant from the following by some secondary reaction, scattered throughout its gangue. The other ores frequently contain it. It also sometimes occurs alloyed with silver, when it forms native amalgam in combination with sulphur and antimony in tetrahedrite.	Entirely volatile, going into vapor at 350° C. (662° F.). Solidifies and crystallizes into octahedra at -38°.8 C. (-37°.9 F.), when it becomes soft and malleable.
Cinnabar.	HgS.	The common ore of quicksilver. Distinguished from realgar by the alliaceous fumes of the latter on charcoal and other characteristics. Usually admixed with clay, iron oxide, or bitumen. Somewhat sectile.	Entirely volatile unless admixed with gangue (quartz, calcite, etc., etc.).
	Mercury, 86.2%	Occurs chiefly in veins in slate rocks, shales, and schists, both the most ancient and the more recent. These rocks are often metamorphic, and dikes of eruptive material are usually found in close proximity. It is also sometimes found in granite, sandstone, limestone, and porphyry. The associated minerals are pyrite, marcasite, sulphides of copper, stibnite, realgar, gold, etc. The gangue minerals are usually calcite, quartz, barite, and fluorite. It is usually not found in large quantities in crystalline or igneous rocks.	
Calomel.	Hg ₂ Cl ₂ .	Tough and sectile. (Rare.) Occurs with cinnabar.	Volatilizes on charcoal, coating the coal white.
	Mercury, 84.9%		

CHARACTERS. TREATMENT WITH ACIDS, ETC.	COLOR.	LUSTRE.	STREAK	FUSI- BILITY.	HARD- NESS.	SP. GR.	CRY- STALLI- ZATION.	MAGNETIC BEFORE OR AFTER HEATING.	USES.
Dissolves readily in Tin-white nitric acid.	Brilliant metallic.				Vol.	14.4	I.		It is largely used in the extraction of gold and silver from their ores by amalgamation, to a less degree in silvering mirrors, for thermometers and barometers, and for many purposes in the arts, in the laboratory, and in medicine, e.g., as bichloride of mercury, the best antiseptic preparation known, calomel, etc.
Mixed with soda in closed tube gives metallic mercury, but alone a black sublimate. In open tube gives reaction for sulphurous acid, and if carefully heated, minute globules of metallic mercury, which condense on the cold portion of the tube.	Red to reddish brown. Some varieties gray or black, but streak red.	Unmetallic to dull and earthy; crystals adamantine.	Scarlet-red.	Vol.	2-2.5	8.9	III.		The paint vermilion, which is used largely in printing, lithographing, etc., is prepared from this ore, having the same chemical composition as the ore.
In nitric solution nitrate of silver gives heavy precipitate of chloride of silver. In closed tube volatilizes without fusion and forms white sublimate.	Gray-white, yellowish gray to brown.	Adamantine.	Yellowish white.	Vol.	1-2	6.4	II.		Of great value in medicine.

NAME.	COMP. AND PERCENTAGE OF IMPORTANT CONSTITUENT.	GENERAL CHARACTERS AND ASSOCIATIONS.	SPECIFIC BEFORE BLOWPIPE.
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MERCURY AND ITS COMPOUNDS.—Continued.

Colora- doite (Mer- cury Tellu- ride).	HgTe.	Rare. Found sparingly in Colorado with gold tellurides. Massive, granular.	In tube decrepitates, fuses, and yields metallic mercury, as well as drops of tellurium dioxide.
	Mercury, 61.5%.		
Mica (Musco- vite). (Isin- glass.) Common rock con- stituent.	Various. $K_2Al_2Si_3O_8$.	Foliated. Very elastic, and is susceptible of being separated into a great number of very thin sheets. Physical characters readily recognized. Foliae tougher and harder than those of talc or chlorite. The latter are non-elastic. Sometimes in large plates, when it possesses considerable value and is extensively mined. It is a very common mineral, and is one of the essential constituents of ordinary granite. It is found in most granites and gneisses, and in dikes of coarse granite traversing a granitic country rock, or in gneiss, mica schist, porphyritic granite, etc.; sometimes in granular limestone. The variety known as amber mica or black mica, which is common in Canada, is biotite or magnesium iron mica. This is usually highly colored by oxide of iron, and this variety supplies nearly the total supply of commerce where transparency is not required. See Uses. Usually associated with such minerals as quartz, feldspar, beryl, tourmaline, garnet, columbite, and samarskite. Cassiterite is the associated mineral in the Black Hills, S. D., and apatite is found in connection with the mica deposits in Canada. It is not uncommon in sedimentary rocks such as micaceous sandstones, grits, shales, etc.	B. B. fuses with difficulty on edges of very thin scales to a gray or yellow glass.

CHARACTERS. TREATMENT WITH ACIDS, ETC.	COLOR.	LUSTRE.	STREAK	FUSI- BILITY.	HARD- NESS.	SP. GR.	CRY- STALI- ZATION.	MAGNETIC BEFORE OR AFTER HEATING.	USES.
Soluble in nitric acid.	Grayish black or iron-black.	Metallic.	Gray-ish.	Vol.	3	8.6	Amorphous		See under heading MERCURY, etc.
Not acted upon by acids. In closed tube yields water.	Colorless, white, gray, brown, yellow, red, and green.	Pearly, transparent to translucent.	White or uncolored.	Above 5.	2-2.5	2.8	IV.		Mica was formerly used in Siberia as a constituent for glass in windows, whence it has been called Muscovy glass. It is in common use in lanterns, for the doors of stoves and furnaces, and other like purposes where a transparent substance not easily affected by heat is desirable. When pulverized it is used in the manufacture of wall-paper in order to give a glistening effect. The consumption of mica is increasing largely at the present time, owing to the fact that usually when more or less finely ground it finds many uses in electrical appliances, being an excellent nonconductor and insulator.

NAME.	COMP. AND PERCENTAGE OF IMPORTANT CONSTITUENT.	GENERAL CHARACTERS AND ASSOCIATIONS.	SPECIFIC BEFORE BLOWPIPE.
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MOLYBDENUM AND ITS COMPOUNDS.

With borax bead in O. F. colorless when hot; faint yellow when cold. With saturation the bead becomes in R. F. an opaque certain chemical operations and analytical work, e.g., in the detection of phosphoric acid, etc.

Molybdenite.	MoS ₂ .	Very soft and sectile. Soils fingers or paper like graphite (<i>q. v.</i>), and looks much like it. Laminæ very flexible, but not elastic.	In forceps colors flame light green or yellowish green, which readily distinguishes it from graphite. This effect is assisted if it is first moistened with H ₂ SO ₄ .
	Molybdenum, 60%.	Occurs in granite, gneiss, syenite, mica schist, and other allied crystalline rocks; also in granular limestone, either imbedded in the rock or disseminated through it. Usually associated with scheelite and apatite, and sometimes with zircon.	
Molybdate of Lead (Wulfenite).	PbMoO ₄ .	Heated on platinum-foil with drops of strong sulphuric acid until copious fumes escape and allowed to cool, then breathed upon, acquires an ultramarine-blue color. Brittle. Occurs with other ores of lead, but is rare and unimportant.	Decrepitates and fuses below 2. With metallic lead; with salt of phosphorus a yellowish-green glass, which is green with black flocks. Solution if diluted with water, and upon zinc and agitated, becomes blue.
	Molybdenum, 26.2%.	Sometimes associated with vanadinite, pyromorphite, etc., upon crystalline limestone.	
Monaite.	Phosphate of the cerium metals, essentially (Ce,La,Di) PO ₄ .	Found in the form of sand, and being sometimes distributed quite abundantly as an accessory constituent of gneissoid rocks in certain regions. Found as rounded grains of sand in gold-washings, as in North Carolina and Brazil. Sometimes known as thorium sands. As its name signifies, it is a rare mineral.	Infusible, turns gray, and when moistened with sulphuric acid colors the flame green. With borax gives a yellow bead when hot and colorless on cooling. A saturated bead becomes enamel-white on flaming. (Dana.)
	Variable. (See Dana's Min.)		

CHARACTERS. TREATMENT WITH ACIDS, ETC.	COLOR.	LUSTRE.	STREAK	FUSI- BILITY.	HARD- NESS.	SP. GR.	CRYs- TALLI- ZATION.	MAGNETIC BEFORE OR AFTER HEATING.	USES.
black or bluish to green enamel when cold.—USES.—While the supply is quite limited, the salts of molybdenum are very useful in									
Heated in platinum spoon with nitre explodes, with evolution of light and heat. In open tube sulphurous fumes and a pale yellow sublimate.	Lead-gray to blackish.	Metallic.	Lead-gray or greenish.	Infus.	1-1.5	4.8	III.		See under heading MOLYBDENUM, etc.
soda on charcoal yields phorus in O. F. gives R. F. becomes dark in HCl greenish, which, addition of tin-foil or	White, red, gray-green, but generally yellowish.	Resinous or adamantine.	White	1-1.5	3	6.9	II.		See under heading MOLYBDENUM, etc.
Soluble with difficulty in HCl.	Hyacinth-red, clove-brown, reddish or yellowish brown.	Inclining to resinous. Sub-transparent to sub-translucent.	Whitish or same as color.	Infus.	5-5.5	5-5.2	V.		The chief use of this mineral is in the manufacture of cylindrical hoods or mantles used in the Welsbach light. (See Rep. U. S. Geol. Sur. 1894-95, Part IV., Min. Res.)

NAME.	COMP. AND PERCENTAGE OF IMPORTANT CONSTITUENT.	GENERAL CHARACTERS AND ASSOCIATIONS.	SPECIFIC
			BEFORE BLOWPIPE.
NICKEL AND ITS COMPOUNDS.—Continued.			
Genthite.	$H_2(Ni,Mg)_6$	The large supply from New Caledonia is derived from garnierite, which is pale green and adhesive to the tongue, and noumeite, which is dark green and unctuous. These ores, which are hydrated silicates of magnesium and nickel, are amorphous, soft, and friable, have a dull lustre, and vary from bright apple-green in color to nearly white.	Reacts for nickel. In O. F. with borax, violet bead becoming red-brown on cooling, which bead, when treated in R. F., becomes gray from reduced nickel.
Impure vari- eties— Garnier- ite, etc. Noume- ite.	Si_2O_{12} . Variable. See de- scription.	Found in veins in decomposed rocks of eruptive origin, among which serpentine is the most important. The New Caledonia ore, as exported for treatment, averages 7% to 10% nickel. It is frequently associated with chrome iron ore and oxide of cobalt. It is sometimes found in talcose schist and associated with phosphate of nickel.	
Emerald Nickel (Zara- tite). (Nickel Carbon- ate.)	$3NiO.CO_2 + 6H_2O$. Nickel, 46.7%.	Incrusting, also massive, compact, minutely mammillated, and stalactitic. Usually containing variable quantities of sulphur, associated with chromic iron, cobalt ores, and magnetite in serpentine rocks.	Becomes magnetic, and gives the nickel reaction with borax.
Pentland- ite.	(Fe,Ni)S.	Sulphides of iron and nickel. Has an uneven fracture and an octahedral cleavage. Not magnetic, and is brittle.	
	Nickel, 39.9%.	Sudbury, Ont., etc., where also an ore which corresponds generally to Ni_3FeS_2 is found. The usual ore of the Sudbury district is a mixture of chalcopyrite and nickeliferous pyrrhotite, the percentage of nickel in the latter varying from 1% to 3% (<i>Min. Ind.</i>). See <i>supra</i> .	
		Usually occurs in close association with chalcopyrite.	Roasted on charcoal gives with fluxes reactions for nickel and iron.

CHARACTERS. TREATMENT WITH ACIDS, ETC.	COLOR.	LUSTRE.	STREAK	FUSI- BILITY.	HARD- NESS.	SP. GR.	CRYs- TALLI- ZATION.	MAGNETIC BEFORE OR AFTER HEATING.	USES.
In closed tube blackens, and gives much water. Decomposed by HCl without gelatinizing.	Apple to emerald green, and sometimes yellowish.	Resinous.	Greenish white.	Infus.	3.4	2.5	Amorphous	After.	See under heading NICKEL, etc.
Soluble in heated dilute HCl, with effervescence. Gives in closed tube a large amount of water, and blackens and leaves grayish-black magnetic residue.	Emerald-green.	Vitreous, transparent to translucent.	Paler than color.	Infus.	3	2.6	Amorphous	After.	See under heading NICKEL, etc.
Yields sulphurous fumes in the open tube.	Light bronze-yellow.	Metallic.	Light bronze-brown.	Easily	3.5-4	4.6	I.		See under heading NICKEL, etc.

NAME.	COMP. AND PERCENTAGE OF IMPORTANT CONSTITUENT.	GENERAL CHARACTERS AND ASSOCIATIONS.	SPECIFIC BEFORE BLOWPIPE.
NICKEL AND ITS COMPOUNDS.—Continued.			
Millerite (Capillary Pyrites). Nickel, (Nickel Blende.)	NiS. 64.6%.	Usually in capillary needle-like crystallizations. Sometimes like wool. Fibrous; also in fibrous crusts. Brittle, capillary crystals elastic. Found with calcite, dolomite, fluorite and ankerite in cavities in hematite, and also with pyrrhotite. Also found with niccolite, nickeliferous iron pyrites, chalcopyrite, etc.	Roasted mineral reacts for nickel as above. On charcoal in R. F. roasted mineral gives a coherent mass, which is attractable by the magnet.
Nickel- iferous Iron Pyrites.	(See Iron Ores and above.)	This frequently contains from 15 to as much as 5% of nickel, and when it does is a valuable Ont., etc. See above. The mines of this district are in Huronian rocks (gneiss and red quartz syenite), and yield, and the rare mineral <i>sperrylite</i> (arsenide of platinum), <i>q. v.</i>	
Ullmannite.	NiSbS.	Brittle and cubic cleavage. Fracture uneven.	After long heating becomes magnetic. Easily fusible, and reacts for antimony, arsenic, and nickel. On charcoal fuses to globules, boils and coats coal white.
	Nickel, 27.8%.		
	Antimony, 57%.		
Nickel Glance (Gers- dorffite).	NiSAs. 35.4%.	Brittle, with uneven fracture. Nickel often replaced by iron or by cobalt to considerable extent.	In a closed tube decrepitates violently and gives yellowish-brown sublimate. On charcoal gives arsenic reaction.
	Arsenic, 45.3%.		

CHARACTERS. TREATMENT WITH ACIDS, ETC.	COLOR.	LUSTRE.	STREAK	FUSI- BILITY.	HARD- NESS.	SP. GR.	CRY- S- TALI- ZATION.	MAGNETIC BEFORE OR AFTER HEATING.	Uses.
Gives no sulphur in closed tube; in open tube, sulphurous fumes.	Brass-yellow inclining to bronze-yellow.	Metallic, often gray iridescent tarnish.	Bright greenish black	Easily	3.5	5.6	III.	After.	See under heading NICKEL, etc.
ore. Magnetic iron pyrites (<i>pyrrhotite</i>) especially is frequently nickeliferous—Sudbury, in addition to <i>pyrrhotite</i> , considerable quantities of <i>chalcopyrite</i> (copper from 1% to 4%).								After.	See under heading NICKEL, etc.
HCl has little effect, but nitric acid or aqua regia dissolves it, with separation of sulphur.	Steel-gray to silver-white.	Metallic.	Grayish black.	3	5.5	6.3	I.	After.	See under heading NICKEL, etc.
Dilute nitric solution, with chloride of barium added, gives heavy precipitate. Aqua regia solution same as copper nickel.	Silver-white to steel-gray and grayish black.	Metallic.	Gray-black.	Easily	5.5	6	I.	After.	See under heading NICKEL, etc.

NAME.	COMP. AND PERCENTAGE OF IMPORTANT CONSTITUENT.	GENERAL CHARACTERS AND ASSOCIATIONS.	SPECIFIC
			BEFORE BLOWPIPE.
NICKEL AND ITS COMPOUNDS.—Continued.			
Nickel Ochre (Nickel Arsenic). (Anna-bergite.)	$\text{Ni}_3\text{As}_2\text{O}_8 + 8\text{H}_2\text{O}$. Nickel. 29.4%. Arsenic, 26.6%.	Soft, earthy, and apple-green in color. Fracture uneven or earthy. With soda on charcoal easily reduced to small, brilliant metallic particles, which are highly magnetic. Probably due to decomposition of niccolite, etc.	On charcoal fuses in R. F. with emission of arsenical vapor to blackish-gray globule, which reacts for nickel with borax. Always contains a little cobalt, which will usually give a blue bead with borax.
Nitre (Common Salt-petre).	KNO ₃ .	Potassium nitrate or potash nitre. Brittle, with uneven fracture. Occurs usually as needle-form crystals and crusts on surface of earth, rocks, and in caves, etc. Spain, Egypt, Persia, and large quantities from India.	On charcoal deflagrates strongly and detonates with combustible substances. Fused on platinum wire colors flame violet.
Variety, Chile salt-petre.	NaNO ₃ .	Sodium nitrate or soda nitre. Somewhat sectile. Deliquescent. Taste cooling. Double refraction in crystals. Occurs granular or massive, and forms beds (<i>caliche</i>) in the Pampa de Tamarugal and elsewhere in Chile, but is found also in small quantities in Nevada and California. Usually associated with large quantities of common salt, gypsum, and other impurities. Iodine is usually present in minute quantities, nevertheless a very large proportion of the supply of commerce is drawn from this source. See <i>Min. Ind.</i> , Vol. II. 345.	Deflagrates less violently than potash nitre, causing yellow light. Colors flame intensely yellow. (Sodium.)

CHARACTERS.	COLOR.	LUSTRE.	STREAK	FUSI-BILITY.	HARDNESS.	SP. GR.	CRYSTALLIZATION.	MAGNETIC BEFORE OR AFTER HEATING.	USES.
TREATMENT WITH ACIDS, ETC.									
The HCl and nitric solutions have a green color. Excess of ammonia colors this sapphire-blue.	Apple-green.	Earthy.	Greenish white.	Easily	Soft.		V.	After.	See under heading NICKEL, etc.
Easily soluble in water. In solution bichloride of platinum produces a yellow crystalline precipitate, especially if stirred with a glass rod for a few minutes. Not altered by exposure. Taste saline and cooling.	White.	Vitreous, sub-transparent.	White	Easily	2	2	IV.		Nitre is largely employed in the manufacture of gunpowder and nitric acid. It is also used in medicine, in metallurgy, and in chemistry, as a powerful oxidizing agent, etc.; to a certain extent for pyrotechnic purposes and fulminating powders.
Dissolves in three parts of water at 60° F. Is strongly deliquescent. Bichloride of platinum produces no precipitate, thus distinguishing it from potassium nitrate.	White, gray, yellowish, orange, reddish brown, and lemon-yellow.	Vitreous, transparent to sub-transparent.	Whitish, or paler than color.	Easily	1.5-2	2.25	III.		This is used to a certain extent in the manufacture of gunpowder, for which purpose it must be first converted into nitre (nitrate of potash), and also in the manufacture of nitric acid, etc. There is a very large and steady demand for Chile saltpetre for use in the preparation of fertilizers throughout Europe, which purpose consumes most of the production.

NAME.	COMP. AND PERCENTAGE OF IMPORTANT CONSTITUENT.	GENERAL CHARACTERS AND ASSOCIATIONS.	SPECIFIC
			BEFORE BLOWPIPE.
Obsidian (Vol- canic glass).	Variable.	<p>All the varieties are amorphous, volcanic products, and are not homogeneous. True obsidian is characterized by intense vitreous lustre, and contains about 70% to 75% silica, and has essentially the same constitution as rhyolite.</p> <p>Occurs in connection with trachytic and more especially rhyolitic outflows. Sometimes occurs as independent sheets or dikes, but more often on the surface of crystallized lava-sheets or on the outer portions of dikes. (Kemp.)</p> <p>Variety: <i>Pumice</i>. This is finely scoriaceous with linear cells, and contains 70% to 78% of silica. (Dana.) It is characterized by a vesicular froth-like structure. Pumice is associated with obsidian.</p>	Fuses with swelling up, at 3.5-4, to a vesicular white glass or enamel.
Opal.	$\text{SiO}_2 \cdot n\text{H}_2\text{O}$.	<p>Composed of silica like quartz, but the true nature of the opal condition of silica is not very clearly understood, but is believed to be one of lower degrees of hardness and specific gravity. Small quantities of iron oxide, alumina, lime, magnesia, and the alkalies are often present, as well as quartz. Exhibits rich play of internal reflections and opalescence, the colors often blending and changing according to the direction in which the stone is held. It differs from quartz in its lustre and in the total absence of crystalline structure. It occurs massive, sometimes small reniform, stalactitic, or large tuberose. (Dana.) It is found usually in cavities or fissures and seams in igneous rocks—usually trachyte and porphyry—also in some metallic veins. It is sometimes found imbedded like flint in limestone or in argillaceous beds. Widely distributed. Fine specimens found in Hungary, Moravia, Silesia, Saxony, Honduras, etc. The so-called <i>fire opal</i> of Mexico is widely distributed throughout Mexico.</p>	Infusible, but becomes opaque. Some varieties containing iron oxide turn red. With soda fuses with effervescence to a clear glass.

CHARACTERS.

TREATMENT WITH ACIDS, ETC.

	COLOR.	LUSTRE.	STREAK	FUSIBILITY.	HARDNESS.	SP. GR.	CRYSTALLIZATION.	MAGNETIC BEFORE OR AFTER HEATING.	USES.
	Various, gray, dull greenish, purplish to red, brown, and black.	Intense vitreous.		3.5-4	6	2.2-2.8	Amorphous		Pumice is used as a powder for polishing ivory, wood, marble, metals, glass, skins, parchment, etc.
Soluble in hydrofluoric acid rather more readily than quartz. Mostly soluble in caustic potassa. Hydrated silica is precipitated by addition of sufficient chloride of ammonia.	Colorless, milky-white, yellow, brown, red, bluish green, and dark grayish green.	Vitreous, subvitreous, resinous, resinous, sometimes pearly. Transparent to nearly opaque.	White	Infus.	5.5-6.5	2-2.3	Amorphous		When displaying brilliant and changing colors used as a gem.



NAME. COMP. AND
PERCENTAGE
OF IMPORTANT
CONSTITUENT.

GENERAL CHARACTERS AND ASSOCIATIONS.

SPECIFIC

BEFORE BLOWPIPE.

PHOSPHATE ROCK.

Mineral variety, apatite, which see. Common variety is often probably replacement of CaCO₃ by phosphate of lime; also Floridite, etc.) or as water-worn fragments, probably derived from this material, or sometimes as concretionary masses (phosph nodules, and furnish a large portion of the commercial supply. The substance examined for phosphorus is mixed with soda, as dropped into it. Then the mixed soda and substance is added so as to cover the magnesium. Heat to full fusion the contents of characteristic odor of hydrogen phosphide is evolved. (Do not have too much water in vessel, and see that end of tube is broken.) to nitric acid solution. An abundant bright yellow precipitate (phosphomolybdate of ammonium) indicates character of the is, chiefly in the preparation of commercial fertilizers, and to a very much smaller extent in the manufacture of phosphorus for converted into soluble phosphate, or superphosphate, by being ground up and mixed with sulphuric acid before it is available as a from certain impurities, such as iron oxide, alumina, etc. Most of the Florida rock contains from 60% to 80% of lime phosphate. (See

PLATI- NUM.	Pt (Ir, Rh, Pd, Fe).	Usually in flattened or angular grains, or irregular masses. Infusible except before oxyhydrogen blowpipe. Sometimes slightly magnetic, malleable, and ductile. Usually alloyed with iron, rhodium, iridium, osmium, and copper. Principal supply obtained from placer deposits.
Native.	Pt = from 50% to 86%.	The commonly associated minerals in such alluvial deposits are, besides quartzose pebbles and sand, magnetic iron sand, gold, iridosmine, topaz, epidote, chromite, garnet, and occasionally zircon, ilmenite, serpentine, chrysolite, peridotite, diamond, etc., Palladium is also rarely found in such deposits. It is rarely found <i>in situ</i> , but has been reported to have been so found in a ferruginous feldspathic rock with iridosmine in New South Wales; also in grains in auriferous veins in Brazil, and occasionally in Russia.

CHARACTERS.

TREATMENT WITH ACIDS, ETC.

COLOR.	LUSTRE.	STREAK	FUSI- BILITY.	HARD- NESS.	SP. GR.	CRY- STALLI- ZATION.	MAGNETIC BEFORE OR AFTER HEATING.	USES.
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includes fossil bones, fossil excrements (coprolites), etc. Occurs massive or in irregular superficial beds (hard rock phosphate—phorite) in river-beds, and usually in stratified marly sediments. Carolinas, Florida, etc. These are referred to as phosphate for sulphur (3 soda, 1 substance). A thin glass tube closed at one end has a piece of magnesium wire or ribbon one-half inch long the tube until the glass is attacked. While still red plunge under water in a small vessel, and immediately apply the nose. The above test is not delicate enough for minute quantities, as in Bessemer iron ores. Best test is to add molybdate of ammonium specimen.—USES.—All the varieties—hard rock, soft rock, land pebble, and river pebble—are used for the same purposes, that making matches, etc. Very large deposits in the southeastern United States furnish great quantities of this material, which must be fertilizer. To be commercially valuable the rock or pebble should contain upwards of 50% of phosphate of lime and be reasonably free (apatite.)

Soluble only in aqua regia. Steel-gray to whitish, rarely black. Metallic. Light gray. Like color. Infus. 4-4.5 16-19 I. After, slightly. A great part of the platinum produced is made into various chemical utensils, such as crucibles, wire, etc. To the chemist it is an invaluable metal. It is also employed by balance-makers

for weights, etc., to a small extent for philosophical and surgical instruments, and in dentistry. Very considerable quantities of it are used in electrical appliances. Somewhat used in jewelry, in photography, in the manufacture of non-magnetic watches, for coating copper and brass, giving a steel-lustre to porcelain, and for other purposes.

NAME.	COMP. AND PERCENTAGE OF IMPORTANT CONSTITUENT.	GENERAL CHARACTERS AND ASSOCIATIONS.	SPECIFIC
			BEFORE BLOWPIPE.
Sperry- lite.	PtAs ₃ . Pt = 56.5%.	Brittle. Occurs in minute crystals or as scales. In nickeliferous iron sulphide (pyrrhotite) or associated with pyrite, chalcopyrite, cassiterite, and as a loose material in small pockets in the decomposed ore, near Sudbury, Ont. (See Nickel ores.)	Decrepitates slightly. When dropped on red hot platinum-foil instantly melts. Gives off inodorous white fumes of arsenic, and porous excrescences which resemble it in color are formed on the foil.
Pyrox- ene (Augite). Common rock constitu- ent (of eruptive rocks es- pecially).	Variable.	Much the same composition as hornblende, which it closely resembles. Sometimes fibrous. Chief varieties are: (a) white augite; (b) green augite; and (c) hypersthene, diallage, bronzite, etc. Massive and disseminated. Common in crystalline limestones and dolomite, in serpentine and in volcanic rocks. Occurs less abundantly in granites and metamorphic rocks. Sometimes, however, forms large veins or beds, or interbedded masses, especially in the older and highly metamorphosed rocks.	Light-colored varieties fuse to a white glass, while the darker varieties give a black glass.

CHARACTERS.	COLOR.	LUSTRE.	STREAK	FUSI-BILITY.	HARD-NESS.	SP. GR.	CRYSTAL-LIZATION.	MAGNETIC BEFORE OR AFTER HEATING.	USES.
TREATMENT WITH ACIDS, ETC.									
In open tube gives arsenic sublimate. Does not fuse if slowly roasted, but if rapidly heated melts easily after part of its arsenic has been driven off. In closed tube unchanged.	Tin-white.	Brilliant, metallic.	Black	As described	6-7	10.6	I.		See under heading PLATINUM, etc.
Most varieties are insoluble in acids.	All colors, usually black, green, and greenish-black.	Vitreous, inclining to resinous and pearly.	White to gray and grayish green.	2-5	5.5	3.5	V.	Iron varieties after.	

NAME.	COMP. AND PERCENTAGE OF IMPORTANT CONSTITUENT.	GENERAL CHARACTERS AND ASSOCIATIONS.		SPECIFIC BEFORE BLOWPIPE.
Ruby.	Al_2O_3 . Oxygen, 47.1%. Alumina, 52.9%.	<p>The gems ruby and sapphire are varieties of corundum, <i>q. v.</i> They are simply the purer kinds of fine colors, which are transparent to translucent, and are useful as gems. The well-known red color of ruby is its distinguishing characteristic. Usually occurs in place in crystalline limestone, also in gneiss, granite, mica slate, chlorite slate, etc., or in the soil derived from their decomposition, and in what is known as gem-bearing gravel. The best rubies come from Upper Burma, north of Mandalay. The associated minerals are of great variety, and usually include some species of the chlorite group. Differs from sapphire only in its color.</p>		Unaltered. Dissolves slowly in borax and salt of phosphorus to a clear glass, which is colorless when free from iron. It is not acted upon by soda.
Rutile.	TiO_2 . Titanic acid, with usually a little iron. $\text{Ti} = 60\%$.	<p>Somewhat resembles tin ore, <i>q. v.</i> Frequently met with as a rock constituent in granite, gneiss, mica slate, and syenitic rocks, and sometimes in granular limestones and dolomite; frequently as secondary product in many slates. Sometimes found as grains or fragments in auriferous and other sands. Often associated with hematite, tremolite, chalcopyrite, tourmaline, etc.</p>		Alone infusible, but with salt of phosphorus gives a hyacinth-red or colorless bead, which becomes violet on cooling, but brownish red if iron is present, as is usually the case. Violet color best produced by reducing bead on charcoal with metallic tin. Distinguished from tin ore by not affording tin with soda.
Sapphire.	Al_2O_3 . Oxygen, 47.1%. Alumina, 52.9%.	<p>A variety of corundum, <i>q. v.</i> Quite widely distributed. Found associated with ruby in the Himalaya Mountains. Also found in Ceylon, in the Rocky Mountains, and in California. Sometimes found in diamond gravels in New South Wales. Compare ruby (<i>q. v.</i>), of which it has the same composition and much resembles, excepting in the matter of color.</p>		Unaltered. Dissolves slowly in borax and salt of phosphorus to a clear glass, which is colorless when free from iron. It is not acted upon by soda.

CHARACTERS.	COLOR.	LUSTRE.	STREAK	FUSIBILITY.	HARDNESS.	SP. GR.	CRYSTALLIZATION.	MAGNETIC BEFORE OR AFTER HEATING.	USES.
TREATMENT WITH ACIDS, ETC.									
Unacted upon by acids, but converted into a soluble compound when fused with potassium bisulphate.	Red.	Vitreous. Transparent to translucent.	Un-colored.	Infus.	9	3.9-4.1	III.		The most highly prized of all gems.
Insoluble in acids alone, but fused with soda or with bisulphate of potash, dissolved in HCl and boiled with tin, the solution becomes violet (titanic acid).	Red, red-brown, yellow, black.	Adamantine, metallic.	Pale brown	Infus.	6.5	4.2	II.	When ferriferous, slightly after.	Rutile is employed for painting on porcelain, and quite largely for giving the requisite shade of color and enamel appearance to artificial teeth. Some kinds make fine though nearly opaque gems.
Unacted upon by acids, but converted into a soluble compound when fused with potassium bisulphate.	Blue.	Vitreous. Transparent to translucent.	Un-colored.	Infus.	9	3.9-4.1	III.		The purer kinds of fine color valuable as gems.

NAME.	COMP. AND PERCENTAGE OF IMPORTANT CONSTITUENT.	GENERAL CHARACTERS AND ASSOCIATIONS.	SPECIFIC
			BEFORE BLOWPIPE.
Silica (Quartz). Most common vein stone and rock con- stituent.	SiO_2 .	<p>Fracture conchoidal to subconchoidal, and uneven to splintery. Brittle to tough. Rock crystal, amethyst, chalcedony, agate, banded onyx, jasper, flint, silicious sinter, petrified (agatized or jasperized) wood, etc., are varieties. Most sandstones are almost entirely made up of an aggregation of small rounded grains of quartz, while it enters very largely into the composition of most other rocks; e.g., common granite is composed of the three minerals quartz, feldspar, and mica.</p> <p><i>Note.</i>—The so-called Mexican onyx is not true onyx, but is calcite usually more or less impure. (See Calcite.)</p> <p>The most common of all rock constituents, and is abundantly met with as such and as a vein stone.</p>	<p>Infusible and unaltered alone. With small quantity of soda fuses, owing to the liberation of CO_2, or dissolves with effervescence to a clear glass (when pure). Unacted on by salt of phosphorus, and with borax dissolves slowly to a clear glass.</p>

SILVER AND ITS COMPOUNDS.

Silver compounds when fused with soda on charcoal yield a hard, white, malleable button, usually without any incrustation with volatile and easily oxidizable metals, it may be separated by heating on charcoal in O. F., but if associated with large white precipitate of AgCl , which is insoluble in boiling nitric acid, but readily soluble in ammonia. The color of the precipitate plate, jewelry, and ornamental objects, and as a money metal. It is also largely used in photography, for numerous chemical preparations,

{ Native. Ag.	Eminently sectile, ductile, and malleable. Sometimes fibrous ("wire" silver), but often massive or in thin sheets or films associated with other ores of silver. Also disseminated, often invisibly, along with other metallic ores. Sometimes associated with native copper and galena. It is doubtless often a secondary product from the ores of silver, and is found accompanying almost all the ores of silver, more frequently the sulphides, sulpho-salts, and chlorides. Occurs in both eruptive and sedimentary rocks.	Fuses to white globule, which in O. F. gives a faint dark-red coating of silver oxide. Crystallizes on cooling.
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CHARACTERS.	COLOR.	LUSTRE.	STREAK	FUSI-BILITY.	HARD-NESS.	SP. GR.	CRY-S-TALI-ZATION.	MAGNETIC BEFORE OR AFTER HEATING.	USES.
TREATMENT WITH ACIDS, ETC.									
Unaffected by hydro-chloric or nitric acid. Soluble only in hydro-fluoric acid. Dissolves in alkaline solutions.	Colorless if pure and usually whitish; often smoky, yellow, red, black, and other shades of color.	Vitreous to greasy. Splendent, to dull. Transparent to opaque.	White or paler than color.	Infus.	7	2.6	III.		Quartz or silica has a number of uses in the industries, especially in the pure state.

It is largely used in the manufacture of glass, for which purpose pure quartz sand is frequently used, though the massive mineral when pulverized and when not impure is equally well adapted. It is also used in the manufacture of pottery, of certain filters, and for many other purposes where silica in a comparatively pure state may be required, especially in an admixture with other substances. When very pure and transparent, sometimes used in the manufacture of eyeglasses, or optical instruments. Chalcedony, jasper, silicified wood, etc., are often carved into ornamental objects.

on the coal, but when treated for a long time with the reducing flame a slight dark-red coating is produced. When associated quantities of lead or bismuth it is best to subject it to cupellation. (See Appendix.) HCl gives in a solution of silver a heavy change to slate-purple by exposure to light. This is a distinguishing characteristic.—Uses.—Silver is principally used for in the manufacture of indelible ink, fulminating powder, etc.

Soluble in nitric acid. The dilute solution, upon addition of HCl (or common salt) gives a white precipitate, which becomes violet-gray on exposure to light. Copper plate immersed in nitric solution is coated with silver.	Silver-white (often tarnished, when it is gray to black).	Metallic.	Silver-white and shining.	Easily, 105° C.	2.8	10.5 when pure.	I.	See under heading SILVER, etc.
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NAME.	COMP. AND PERCENTAGE OF IMPORTANT CONSTITUENT.	GENERAL CHARACTERS AND ASSOCIATIONS.	SPECIFIC BEFORE BLOWPIPE.
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SILVER AND ITS COMPOUNDS.—Continued.

Silver Glance, Argentite (Sulphide or Sul- phuret (O. S.) of Silver).	Ag ₂ S.	Can be cut with a knife like lead when massive, but it is usually finely disseminated through the vein material. This is probably the most common ore of silver.	On charcoal in O. F. intumesces, gives off odor of sulphur, and yields a globule of silver.
	Silver, 87.1%.	Occurs abundantly with stephanite, native gold, also native silver and copper.	
Brittle Silver (Steph- anite). Kindred anti- monial and ar- senical ores are:	Ag ₃ SbS ₄ .	Brittle, with an uneven fracture. Occurs in veins, etc., with other silver ores.	Gives odor of sulphur, also fumes, and coating of antimony, and yields a dark metallic globule, which after long blowing is colored red from oxidized silver, and from which silver may be obtained by addition of soda and heating in reducing flame.
	Silver, 68.5%.	<i>Note.</i> —A variety is <i>dyscrasite</i> (Ag ₃ Sb), but its composition is variable. The following antimonial and arsenical silver ores pass readily one into another by almost insensible gradations, and the analyses of them often vary very widely, owing to presence of impurities.	
Miargy- rite.	Ag ₃ S.Sb ₂ S ₃ .	Brittle, with uneven fracture. Contains less silver than some of the kindred ores.	Fuses on charcoal quietly to a gray bead, with emission of sulphur and antimony fumes. If this bead is treated for some time in O. F. a bright globule of silver is obtained.
	Silver, 36.9%.	Occurs with the other ores of silver.	

CHARACTERS. TREATMENT WITH ACIDS, ETC.	COLOR.	LUSTRE.	STREAK	FUSI- BILITY.	HARD- NESS.	SP. GR.	CRYS- TALLI- ZATION.	MAGNETIC BEFORE OR AFTER HEATING.	USES.
As above under native silver. In open tube gives off sulphurous fumes.	Blackish lead-gray.	Metallic.	Shining gray-black.	1.5	2-2.5	7.3	I.		See under heading SILVER, etc.
Soluble in dilute nitric acid, leaving residue of sulphur and oxide of antimony, copper plate becoming plated with silver as above under native silver. Heated in closed tube fuses with decrepitation and gives slight sublimate of sulphide of antimony after long heating.	Iron-black.	Metallic.	Iron-black.	1	2.5	6.3	IV.		See under heading SILVER, etc.
Decomposed by nitric acid, with separation of sulphur and antimony trioxide. Decrepitates in closed tube and yields antimony sublimate. In open tube sulphurous and antimonial fumes.	Iron-black to steel-gray. In splinters blood-red.	Metallic—adamantine, nearly opaque.	Reddish.	Easily	2-2.5	5.2	V.		See under heading SILVER, etc.

NAME.	COMP. AND PERCENTAGE OF IMPORTANT CONSTITUENT.	GENERAL CHARACTERS AND ASSOCIATIONS.	SPECIFIC
			BEFORE BLOWPIPE.
SILVER AND ITS COMPOUNDS.—Continued.			
Dark-red Silver Ore (Pyrargyrite).	Ag ₂ SbS ₃ . Silver, 59.9%.	Brittle with uneven or conchoidal fracture. Occurs with the other ores of silver, and principally with calcite, native arsenic, galena, etc.	On charcoal fuses with spitting to a globule, and gives a white sublimate of antimony trioxide.
Light-red Silver Ore (Proustite).	Ag ₂ AsS ₃ . Silver, 65.4%.	Like above, except that Sb is replaced by arsenic. Found with the other ores of silver, especially pyrargyrite, cerargyrite, native silver, and gold.	On charcoal gives garlic odor of arsenic and sulphur.
Polybasite.	Ag ₂ SbS ₃ . Silver, 75.6%.	Uneven fracture. Copper is often present. Arsenic often replaces the antimony. Otherwise the formula remains the same (Mollie Gibson mine, etc., Colorado). A somewhat related ore is <i>freieslebenite</i> , (PbAg) ₂ Sb ₂ S ₃ , containing from 30% to 50% of lead and from a trace to 27% of silver.	Fuses with spitting to a globule. Gives off sulphur, sometimes arsenic, and coats the coal white. Arsenical variety gives off characteristic garlic odor of arsenic.
Stromeyerite (Silver-copper Glance).	Ag ₂ S + Cu ₂ S. Silver, 53.1%.	Steel-gray argentiferous copper sulphide. Fracture subconchoidal. Usually found associated with chalcopyrite and galena.	Fuses and gives in open tube an odor of sulphur. Silver globule yielded only by cupellation with lead.

CHARACTERS. TREATMENT WITH ACIDS, ETC.	COLOR.	LUSTRE.	STREAK	FUSI- BILITY.	HARD- NESS.	SP. GR.	CRY- STALLI- ZATION.	MAGNETIC BEFORE OR AFTER HEATING.	USES.
Like stephanite.	Dark red to black or grayish black.	Metallic—adamantine.	Red.	I	2.5	5.8	III.		See under heading SILVER, etc.
Decomposed by nitric acid with separation of sulphur.	Cochineal-red or scarlet.	Adamantine.	Vermilion, rarely aurora-red to orange-yellow.	I	2.5	5.5	III.		See under heading SILVER, etc.
Decomposed by nitric acid, etc.	Iron-black. In thin splinters cherry-red.	Metallic.	Black.	Easily	2-3	6.1	IV.		See under heading SILVER, etc.
Nitric solution gives with HCl a heavy precipitate.	Dark steel-gray.	Metallic.	Same as color, but more shining.	Easily	2.5-3	6.25	IV.		See under heading SILVER, etc.

NAME.	COMP. AND PERCENTAGE OF IMPORTANT CONSTITUENT.	GENERAL CHARACTERS AND ASSOCIATIONS.	SPECIFIC BEFORE BLOWPIPE.
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SILVER AND ITS COMPOUNDS.—Continued.

Horn Silver or Silver Chlo- ride (Cerar- gyrite). Kindred and asso- ciated ores are:	AgCl. Silver, 75.3%.	The common ore of Mexico and South America. Not common, except in southern part, in the United States. A very valuable ore, as it is easy of treatment (free-milling). It is an alteration product of the foregoing ores and owes its origin in many cases probably to the percolation of sea or salt water throughout the upper portions of the veins or other classes of deposits, as in depth the ores invariably change into their original condition of sulphides. Highly sectile when very pure, cutting like hard wax or a piece of horn; hence its name. Fracture somewhat conchoidal. No cleavage. Occurs massive and waxlike, or as incrustations. Found associated with the other ores of silver, but usually for the reasons given above, in the upper portions of the veins containing silver ores. Often associated with oxide of iron and other alteration products. Found frequently with copper ores, calcite, barite, etc. A rare variety is <i>huantajayite</i> ($20\text{NaCl} + \text{AgCl}$), which is found near Iquique, Chile, only, however, to a depth of 20 metres.	Fuses in flame of candle, emitting acrid fumes (Cl). Malleable and sectile. On charcoal yields a globule of metallic silver. In salt of phosphorus bead, to which oxide of copper has been added, and heated in O. F., an intense azure-blue color is imparted to the flame.
Embolite, which passes into	Ag(ClBr). Silver, about 64%. Very variable. Ratio of chlorine to bromine varying in- definitely.	Fracture uneven, no cleavage, sectile. The yellow and deep-green varieties contain the largest quantities of bromine. Abundant in Chile. Associated with the other silver ores, of which it is an alteration product. Also frequently associated with cerussite.	Pungent bromine vapors are emitted when it is heated on charcoal, and a button of metallic silver remains.

CHARACTERS. TREATMENT WITH ACIDS, ETC.	COLOR.	LUSTRE.	STREAK	FUSI- BILITY.	HARD- NESS.	SP. GR.	CRYSS- TALLI- ZATION.	MAGNETIC BEFORE OR AFTER HEATING.	USES.
Soluble in ammonia, but not in nitric acid. In closed tube with bisulphate of potassa gives off acid vapors. Fuses to a pale hyacinth-red globule. Becomes yellow when cold. A plate of iron rubbed with the mineral becomes silvered.	Pearl-gray, whitish, and colorless; upon exposure to light turns into violet and other tints of brown. Passes into green and blue. Rarely violet-blue.	Resinous-adamantine.	Shining, transparent to subtranslucent.	Very easily	1-1.5	5.5	I.		See under heading SILVER, etc.
In closed tube gives off bromine vapors and fuses to an intense garnet-red globule, which is yellow when cold. Soluble in ammonia, but not as soluble as the above.	Gray-green, asparagus-green to yellow and green-yellow; becomes darker on exposure.	Resinous to somewhat adamantine.	Shining.	Easily	1-1.5	5.4	I.		See under heading SILVER, etc.

NAME.	COMP. AND PERCENTAGE OF IMPORTANT CONSTITUENT.	GENERAL CHARACTERS AND ASSOCIATIONS.	SPECIFIC BEFORE BLOWPIPE.
SILVER AND ITS COMPOUNDS.—Continued.			
Bromy- rite.	AgBr.	No cleavage and fracture uneven, sectile. Abundant in Chile.	Same as above.
Silver,			
	57.4%		
Iodyrite.	AgI.	Perfect cleavage. Sectile, plates flexible. Chile, New Mexico, Arizona, Spain, etc.	B. B. gives fumes of iodine and metallic silver.
Silver, 46%.		Same as above.	
Iodine, 54%.			

Argentiferous Galena. (See Lead ores.) This very frequently carries silver, and is a *very* common ore of the latter.

Argentiferous Cerussite. (See Lead ores.) This very frequently carries silver, and is a *very* common ore of the latter. Results

Argentiferous Zinc Blende. (See Zinc ores.) This less frequently carries silver. Generally associated with galena, iron and

Argentiferous Pyrites. (See Iron and Copper ores.) The various kinds of pyrites very frequently carry small percentages of silver.

CHARACTERS. TREATMENT WITH ACIDS, ETC.	COLOR.	LUSTRE.	STREAK	FUSI- BILITY.	HARD- NESS.	Sp. Gr.	CRYs- TALLI- ZATION.	MAGNETIC BEFORE OR AFTER HEATING.	USES.
In closed tube and with metallic zinc much the same reaction as cerargyrite. Fused with potassium bisulphate gives off yellowish-brown vapors (Br). With difficulty soluble in ammonia.	When pure bright yellow to amber-yellow; often grass-green or olive-green. Externally little altered on exposure.	Resinous to adamantine.	Shining or like color.	Easily	2-3	5.5-6	I.		See under heading SILVER, etc.
In closed tube fuses and assumes deep orange color, but is yellow on cooling. Fused with potassium bisulphate in a matrass yields violet vapors, and the globule becomes very dark or almost black.	Citron and sulphur-yellow to yellowish green; sometimes brownish.	Resinous to adamantine.	Yellow, translucent.	Easily	Soft.	5.7	III.		See under heading SILVER, etc.

usually from superficial decomposition of above.

copper pyrites, etc., in silver mines.

NAME.	COMP. AND PERCENTAGE OF IMPORTANT CONSTITUENT.	GENERAL CHARACTERS AND ASSOCIATIONS.	SPECIFIC BEFORE BLOWPIPE.
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SILVER AND ITS COMPOUNDS.—Continued.

Tetrahedrite (Gray Copper). (See Copper ores.) This frequently carries a large percentage of silver, but not often found in

SULPHUR AND SULPHIDES.

The following is usually sufficient to detect the presence of sulphur: Mix the substance suspected to contain sulphur with silver (coin or plate), and a drop of water is added. A yellowish stain on the silver indicates a trace of sulphur; larger sulphur. Mixed with soda as above and heated in O. F. on platinum wire, the sulphides color the coin brown to black, but and colors the coin. Sulphides, or substances containing sulphides in considerable quantities, yield sulphur dioxide when heated inserted in end of tube. Usually soluble in nitro-hydrochloric or concentrated nitric acid. Some are extremely difficult to dissolve upon it, but these can usually be recognized by their volatility, etc. (mercury, arsenic, etc.). The higher sulphides give off sulphur of burning sulphur. — Uses. — *The chief use of sulphur is, of course, in the manufacture of sulphuric acid, this acid being produced in lucifer-matches, for bleaching, and for medicinal purposes.*

Sulphur.	S.	Taste is scarcely perceptible, odor when rubbed faintly sulphurous. Yellow when pure, but usually gray or brown because of admixture with earthy substances, clay, bitumen, etc. Fracture conchoidal to uneven. Associated with gypsum, calcite, celestite, and abundant in regions of present and ancient volcanic activity. Andes, Sicily, Mexico, Yellowstone Park, and almost world-wide distribution. Found often near sulphur springs, in many coal deposits, and at other places where pyrites is undergoing decomposition.	Melts at 108° C. (some varieties at 114° C.) and at 270° burns with blue flame, emitting the suffocating odor of sulphurous acid gas, which it forms by combining with the oxygen of the air.
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TELLURIUM AND ITS COMPOUNDS.

Rarely occurs native, when it is a white and brittle metal, which is easily fusible, volatilizing almost entirely and tinging decomposing horse-radish. Usually combined with the other metals as tellurides of gold, silver, lead, and bismuth, which see. In in nitric acid. Occurs usually accompanying quartz, pyrite, gold, fluor-spar, etc. — Uses. — *Of no use in the arts.*

CHARACTERS.	COLOR.	LUSTRE.	STREAK	FUSI- BILITY.	HARD- NESS.	SP. GR.	CRY- SILLI- ZATION.	MAGNETIC BEFORE OR AFTER HEATING.	USES.
TREATMENT WITH ACIDS, ETC.									

large quantities. When argentiferous its color is usually steel-gray, or lighter than the ordinary varieties.

soda (3 soda, 1 substance) and heat on platinum wire or charcoal in R. F. The fused mass is then crushed on a clean piece of quantities give a brown or a black stain. Sulphides such as pyrites, galena, etc., heated on charcoal give the odor of burning sulphates, gypsum, baryta, etc., so treated in O. F., do not color the coin; in R. F., however, the sulphate is changed to sulphide in open tube. The sulphur dioxide may be recognized by its odor, and by reddening and sometimes bleaching blue litmus paper completely, owing to the deposition of sulphur, which fuses around the unaltered substance and prevents any action of the acid when heated in closed tube. Free sulphur (*q. v.*) fuses and sublimes, and on charcoal burns with a blue flame, and affords odor commercial quantities only from native sulphur and pyrites. It is also largely used, however, in the manufacture of gunpowder and

Insoluble in water. Natural and artificially formed crystals are soluble in disulphide of carbon, but the amorphous form is not. Crystal-line forms also soluble in sulphide of chlorine, benzine, turpentine, etc. Not acted on by acids.	Sulphur-yellow, gray, brown, or reddish to greenish.	Resinous.	Like color.	Easily	1.5-2.5	2.07	IV.	See under heading SULPHUR, etc.
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the flame green. White coating on charcoal. It fumes strongly, and in presence of selenium gives the peculiar odor of open tube a white or grayish sublimate (tellurium dioxide) is obtained, which may be fused to clear, colorless drops. Soluble

NAME.	COMP. AND PERCENTAGE OF IMPORTANT CONSTITUENT.	GENERAL CHARACTERS AND ASSOCIATIONS.	SPECIFIC BEFORE BLOWPIPE.
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TIN AND ITS COMPOUNDS.

Fused with soda and borax on charcoal in R. F., the compounds of tin yield a globule of the metal. At the same time a must be kept covered with the blue R. F. The coating moistened with cobalt solution and heated in the O. F. assumes a bluish-with metallic zinc, metallic tin is thrown down in the form of scales, or as a gray spongy mass.—USES.—Tin, as a metal, has a sheet iron (tin plate), etc. It is largely used as an alloy, e.g., with copper, forming bell-metal, in the manufacture of solders, etc. It is employed for polishing hard stone and sharpening fine cutting instruments and in enamels. The chlorides are used in dyeing and bronze-powder.

Tin Stone (Cassiterite). (Stream Tin.)	SnO ₂ . Tin, 78.6%.	Practically the only ore. Its high specific gravity is very noticeable; likewise its hardness. (Compare garnet and rutile.) Fracture uneven or subconchoidal. When found in place it is usually associated with quartz, copper, and iron pyrites, wolframite, mica, tourmaline, apatite, fluorite, sphalerite, molybdenite, arsenopyrite, etc. When in place it is usually found in veins in granite, quartzose gneiss, quartzite, metamorphic slate, mica schist, and porphyry. It is, however, quite largely obtained from placer deposits, when it is frequently associated with platinum, iridosmine, gold, corundum, etc.	B. B. alone unaltered. With soda on coal reduced to metallic tin, and gives a white coating. Requires long blowing. Hastened by addition of potassium cyanide. The globule is malleable, and reacts for tin. Sometimes reacts for iron and manganese. The fine powder gives tin reaction with cobalt nitrate.
Tin Pyrites (Stan-nite).	Cu ₂ S, FeS, SnS. Tin, 27.5%. Copper, 29.5%.	Sulphide of tin. "Bell-metal ore." Rare. Easily fusible. Massive, granular, and disseminated. Cubic cleavage, uneven fracture, and brittle. Often yellowish from presence of copper pyrites. Zinc is often present. Commonly found massive and associated with tin-stone (cassiterite), wolframite, also in quartz with native bismuth, scheelite, pyrite, galena, sphalerite, etc.	On charcoal after long blowing fuses to a brittle metallic globule, which in O. F. gives off sulphur and coats the coal white with oxide of tin. In open glass tube gives off sulphur (forming fumes of sulphurous acid) and also forming close to assay sublimate of oxide of tin, which cannot be volatilized by heat.

CHARACTERS.

COLOR.

LUSTRE.

STREAK

FUSI-
BILITY.HARD-
NESS.

SP. GR.

CRY-
S-
TALLI-
ZATION.MAGNETIC
BEFORE
OR AFTER
HEATING.

USES.

TREATMENT WITH ACIDS, ETC.

coating is formed on the coal, which is slightly yellow when hot, but white when cold. To obtain a coating, however, the assay green color. Sulphides should always be roasted. When a solution of salts of tin, acidulated with HCl, is brought in contact wide application in the industries. It is employed for making castings, and very extensively for coating iron and copper vessels, especially also used in the manufacture of tin-foil, and when amalgamated with mercury for silvering mirrors. The dioxide (prepared artificially) calico-printing. The bisulphide, on account of its golden lustre, is used in ornamental painting, etc., and known under the name of

Insoluble in acids or only slightly acted upon.	Brown, black, and brown-black, sometimes red, gray, white, or yellow.	Adamantine to dull. Crystals usually splendent.	White-grayish to brown. Transparent to opaque	Infus.	6-7	6.8-7.1	II.	See under heading TIN, etc.
Soluble in nitric acid to a blue solution, with separation of sulphur and bioxide of tin.	Steel-gray (when pure) to brown-black. Sometimes a bluish tarnish.	Metallic.	Black-ish.	Easily	4	4.4	Usually massive.	See under heading TIN, etc.

NAME.	COMP. AND PERCENTAGE OF IMPORTANT CONSTITUENT.	GENERAL CHARACTERS AND ASSOCIATIONS.	SPECIFIC BEFORE BLOWPIPE.
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Topaz.	$\text{Al}_{12}\text{Si}_6\text{O}_{26}\text{F}_{10}$	Cleavage both perfect and imperfect. Fracture subconchoidal to uneven. Brittle. The colorless varieties resemble diamonds, but are easily distinguished from them in that they are of inferior hardness, that they lack "fire" and become electric when heated. The color of the deep wine-red crystals is apt to fade out on exposure to daylight, and the yellow color of some of the crystals from Brazil is changed to rose-red by being heated. Oriental topaz is yellow corundum and Scotch topaz is yellow smoky quartz, from each of which true topaz is easily distinguished. Occurs either crystallized, in association with granitic, gneissoid, or talcose rocks, or in the form of rolled pebbles in gravel. The associated minerals are tourmaline, mica, beryl, and sometimes apatite, fluorite, and cassiterite. Sometimes found in cavities in rhyolite and similar volcanic rocks. Obtained from Brazil. Also found in New South Wales, Tasmania, Mexico, and sometimes in the United States.	B. B. Infusible. Fused in closed tube with salt of phosphorus previously fused, etches the glass and gives off silicon fluoride. Some varieties become yellow or more often pink when heated. Moistened with cobalt nitrate and ignited assumes a fine blue color.
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TUNGSTEN AND ITS COMPOUNDS.

Before blowpipe compounds of tungsten impart to salt of phosphorus bead at first a dirty-green, then a blue color when phosphoric acid its compounds give a beautiful blue syrup. Often associated with tin ores, etc. The ores are rare.—Uses—The hardening steel), the tungsten imparting to the steel a high degree of hardness. Tungstate of soda has been employed as a mordant in like alum, can, however, be used for the same purpose. Also used for hardening plaster of Paris and in the manufacture of tungstic acid.

Wolframite.	(Fe,Mn.) WO_4 .	Swedish heavy stone. Its true nature will be suspected from its great weight, very dark-grayish or reddish-black color, submetallic or adamantine lustre, and red-brown streak. Tungstate of iron and manganese. Both massive and crystalline. Breaks readily into angular fragments. Variety, Tungstite (WO_3), which reacts for tungsten only, and which occurs in soft, bright yellow or yellowish-green earthy masses. Due to decomposition of wolframite, which, commercially speaking, is the only ore. Hubnerite is a nearly pure manganese wolframate (MnWO_4). Usually occurs in quartz veins, sometimes quite massive, sometimes disseminated throughout the vein material, and frequently as nests or bunches irregularly distributed through the gangue. Very frequently associated with cassiterite, also with bismuth, scheelite, pyrite, galena, sphalerite, etc., sometimes with gold.	Fuses quite easily to gray and often crystalline globule which is magnetic. With borax manganese reaction. With soda on platinum-foil gives the bluish-green manganese reaction. With salt of phosphorous gives a clear reddish-yellow glass when hot, which is paler on cooling; in R. F. becomes dark red; on charcoal with tin, if not too saturated, bead becomes green on cooling, and with continued treatment in R. F. changes to reddish yellow. Often feebly magnetic.
Tungsten trioxide = 76.47%.	Manganese and Iron very variable.		

CHARACTERS.

TREATMENT WITH ACIDS, ETC.	COLOR.	LUSTRE.	STREAK	FUSI-BILITY.	HARDNESS.	SP. GR.	CRYSTALLIZATION.	MAGNETIC BEFORE OR AFTER HEATING.	USES.
Not affected by acids or only partially affected by sulphuric acid.	Colorless, pale yellow, white, bluish, greenish and reddish.	Vitreous. Transparent to subtranslucent.	White.	Infusible or fusible above 5.	8	3.4-3.65	IV.		The purer varieties are used as gems in jewelry. Owing to its perfect cleavage, it is a poor substitute for emery.

cold. If iron is present the bead appears blood-red. Best with tin on charcoal. Characteristic reaction is when boiled with chief use of tungsten ore is in the preparation of ferro-tungsten and tungsten metal for making tungsten steel (ordinarily called self-dyeing, and for the impregnation of vegetable tissues, linen, cotton, and other light fabrics, to render them non-inflammable. Cheaper salts,

Reduced to fine powder and boiled with aqua regia, assumes gradually a yellow color. Boiled with phosphoric acid gives a beautiful blue syrup (tungsten). The blue syrup is changed to violet by addition of nitric acid. It is sufficiently decomposed by concentrated sulphuric or even hydrochloric acid to give a colorless solution which, when treated with metallic zinc, becomes intensely blue, but soon bleaches on dilution.	Black, dark grayish to brownish black. Also brownish red and hair-brown.	Submetallic to resinous, adamantine. Sometimes splendent.	Black to dark reddish brown, yellowish brown and greenish gray.	2.5-3	5.5	7.2	V.	Both.	See under heading TUNGSTEN, etc.
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NAME.	COMP. AND PERCENTAGE OF IMPORTANT CONSTITUENT.	GENERAL CHARACTERS AND ASSOCIATIONS.	SPECIFIC BEFORE BLOWPIPE.
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TUNGSTEN AND ITS COMPOUNDS.—Continued.

{	Scheel-ite.	CaWO ₄ .	Cleavage very distinct. Brittle, with uneven fracture. Reniform, massive, granular. Molybdenum is usually present, replacing part of the tungsten. Found usually in crystalline rocks associated with tinstone, apatite, fluorite, topaz, wolframite, molybdenite, and in quartz along with gold, etc.	In forceps fuses with some difficulty to a semi-transparent glass. With borax the glass is transparent, but on cooling it becomes opaque and crystalline. With salt of phosphorus the glass is colorless in the outer flame, but is green in the inner flame when hot, and a fine blue when cold. If iron is present specimen must be treated with tin before this effect is obtained.
	Tungsten, 63.8%.			
Tur-quois.	2Al ₂ O ₃ , P ₂ O ₅ , 5H ₂ O.	A hydrous phosphate of aluminum colored by presence of some compound of copper. Rather brittle, no cleavage. In thin seams and disseminated grains. Usually in trachytic rocks, or in the neighborhood of them, as very thin seams or small masses in the cracks or joint planes, etc.	In forceps becomes brown and glassy, but does not fuse. Colors flame green. Moisten with HCl the color is at first blue. With the fluxes gives yellowish-green beads when hot, which are pure green on cooling.	
	Variable.	In Persia it is found not only in the brecciated trachyte, but in the surrounding clay slate.		

CHARACTERS. TREATMENT WITH ACIDS, ETC.	COLOR.	LUSTRE.	STREAK	FUSI- BILITY.	HARD- NESS.	SP. GR.	CRY- STALLI- ZATION.	MAGNETIC BEFORE OR AFTER HEATING.	USES.
In hydrochloric or nitric acid is decomposed, leaving a yellow powder which is soluble in ammonia.	Yellow, yellowish white, pale yellow, brownish, greenish, reddish, and rarely orange-yellow.	Vitreous to adamantine. Transparent to translucent.	White	5	4.5-5	6	II.		See under heading TUNG-STEN, etc.
Soluble in hydrochloric acid. In closed tube decrepitates, yields water, and turns brown or black.	Sky-blue, bluish green to apple-green and greenish gray.	Waxy, feeble.	White or greenish.	Infus.	6	2.6			The principal use is in jewelry. Fossil bones and teeth colored by phosphate of iron, and termed <i>odontolite</i> , or bone turquoise, are frequently cut and polished for the same purpose.

NAME.	COMP. AND PERCENTAGE OF IMPORTANT CONSTITUENT.	GENERAL CHARACTERS AND ASSOCIATIONS.	SPECIFIC
			BEFORE BLOWPIPE.
Wollastonite (Tabular Spar). (A vein-stone.)	CaO ₂ Si.	A somewhat rare veinstone (in the same sense that baryta, calcite, etc., are veinstones). Brittle, with uneven fracture, but perfect cleavage. Usually with long fibres or columnar structure. In granitic regions, in granular limestones, and along with some basaltic lavas. Often found associated with lime garnet, pyroxene, etc.	Fuses quietly, but with difficulty, to a colorless translucent glass. In closed tube no change. With much soda swells up and becomes infusible.

ZINC AND ITS COMPOUNDS.

Compounds of zinc with borax give a clear glass, which is milk-white on flaming, or with more assay becomes enamel-white is yellow when hot, but white when cold. With soda on charcoal the ores, even when containing little zinc, afford the peculiar yellowish- or dirty-green color is obtained (either alone or with soda), while tin gives a bluish-green color when similarly what is known as galvanized iron. Its alloys with copper, lead, tin, and other metals are of great importance; e.g., with copper making

Zinc-blende (Sphalerite; Black-jack).	ZnS. Zinc, 67%.	The most abundant ore. Generally can be recognized by its appearance. It is massive, cleavable, coarse to fine granular, and compact; also foliated and fibrous, radiated and botryoidal. Brittle. Fracture conchoidal. Sometimes contains iron, manganese, etc. Is frequently argentiferous or auriferous. Common in silver mines. Occurs in rocks of all ages, in veins, in contact deposits, or in irregular pockets in limestone, etc., and is frequently associated with the ores of lead, as well as those of copper, iron, silver, gold, and tin; also frequently associated with quartz, barite, fluorite, calcite, etc. Widely distributed.	With soda on charcoal gives in R. F. a strong green zinc flame and a coating of oxide of zinc, with fumes of sulphur. Alone on charcoal gives fumes of zinc when strongly heated. Sometimes phosphorescent when rubbed or struck with a stick.
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CHARACTERS.	COLOR.	LUSTRE.	STREAK	FUSIBILITY.	HARDNESS.	SP. GR.	CRYSTALLIZATION.	MAGNETIC BEFORE OR AFTER HEATING.	USES.
TREATMENT WITH ACIDS, ETC.									
Decomposed by HCl, frequently effervesing slightly from presence of small quantities of calcite, and gelatinizing. After separation of the silica, carbonate of ammonia causes a copious separation of carbonate of lime.	White to whitish gray. In some specimens yellowish, reddish, and brownish.	Vitreous to pearly on cleavage surfaces.	White	4.5	4.5	2.9	V.		
Dissolves in nitric acid, emitting sulphuretted hydrogen. Soluble also in HCl.	Brown, yellow to black, sometimes green, red, and white; nearly colorless when pure.	Resinous or waxy to adamantine.	Brownish to light yellow and white. Transparent to translucent.	Infus.	3.5-4	4	I.	See under heading ZINC, etc.	

NAME.	COMP. AND PERCENTAGE OF IMPORTANT CONSTITUENT.	GENERAL CHARACTERS AND ASSOCIATIONS.	SPECIFIC BEFORE BLOWPIPE.
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ZINC AND ITS COMPOUNDS.—Continued.

Zinc Carbon- ate (Smith- sonite; “Dry- bone”).	ZnCO ₃ . Fe, Mn, Ca, and Mg often present. Zinc, 52%.	Crystals over drusy surface usually terminate in sharp three-sided pyramids. Faces of crystals generally rough and curved. Reniform, botryoidal, or stalactitic and incrusting. Roughly friable and sometimes earthy. Usually rough and granular. Markedly harsh to feel. Brittle. Cleavage perfect, but fracture uneven. Found in veins, but more usually in irregular deposits in limestone strata. Usually produced by action upon zinc sulphide of carbonated waters, and is therefore nearly always an alteration product of the originally deposited ore. Associated with blende, calamine, galena, and with limonite and copper ores. An earthy variety is zinc-bloom. (hydrozincite).	Infusible alone, but CO ₂ and zinc oxide are finally vaporized with soda on charcoal, producing coating which can be treated as above.
Zinc Silicate (Calam- mine; Electric Cala- mine).	Zn ₂ SiO ₄ + H ₂ O. Zinc, 54.2%.	Stalactitic, mammillary, botryoidal, fibrous, but also massive and granular, sometimes cellular. In physical characters somewhat resembles the preceding ore. An anhydrous variety of this ore is <i>willemite</i> , which is found with the two following ores in New Jersey (Mine Hill and Sterling Hill). Like the former, it is usually found in veins, or in beds, or in irregular pockets in stratified calcareous rocks, in association with zinc-blende, zinc carbonate, iron and lead ores, etc.	The smallest fragment heated attracts light substances. Pyro-electric. Almost infusible. Moistened with cobalt solution gives a blue color when heated.

CHARACTERS. TREATMENT WITH ACIDS, ETC.	COLOR.	LUSTRE.	STREAK	FUSI- BILITY.	HARD- NESS.	SP. GR.	CRY- S- TALLI- ZATION.	MAGNETIC BEFORE OR AFTER HEATING.	Uses.
Gives little or no water in closed tube. Dissolves in HCl, with evolution of carbonic acid, causing effervescence.	Impure white to grayish, sometimes green or brownish and other tinges.	Vitreous, pearly. Sub-transparent to translucent.	Un-colored or white.	Infus.	5	4.4	III.		See under heading ZINC, etc.
Gives much water in closed tube. With HCl forms a perfect jelly even when previously ignited. Decomposed by acetic acid and soluble in strong solution of caustic potash.	Whitish or white, sometimes with bluish-green or brownish tinges. Also yellowish to brown.	Vitreous or sub-pearly to adamantine.	Un-colored or white.	6	4.5-5	3.5	IV.		See under heading ZINC, etc.

NAME.	COMP. AND PERCENTAGE OF IMPORTANT CONSTITUENT.	GENERAL CHARACTERS AND ASSOCIATIONS.	SPECIFIC BEFORE BLOWPIPE.
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ZINC AND ITS COMPOUNDS.—Continued.

Red Oxide of Zinc (Zincite; Ruby Zinc).	ZnO, MnO is frequently present. Zinc, 80.3%.	Distinguished by its eminent cleavage, infusibility, and by its mineral associations. It is brittle and has subconchoidal fracture. On exposure to the air it decomposes superficially and becomes coated with white films of zinc carbonate. Occurs with franklinite and willemite in New Jersey, and sometimes in lamellar masses in pink calcite.	Infusible alone, but yields a yellow transparent glass with borax. If manganese be present, the bead is amethystine. Zinc coating on coal when treated with soda in R. F.
Franklinite.	(Fe,Zn,Mn) O.(Fe,Mn), O ₂ . Variable.	See Iron Ores, among which it is enumerated, although it is a very important zinc ore and is extensively manufactured in Hill and Mine Hill, N. J. Usually contains about 10% zinc, the residuum, known as "clinker,"	
Zircon.	ZrSiO ₄ .	Zinc, 12% (?). A somewhat rare mineral. Generally in crystals (square four-sided prisms terminated by four-sided pyramids); also in grains, etc. Brittle. Conchoidal fracture. Confined to crystalline rocks, usually occurring in granite, syenite, some of the gneisses, granular limestone, chloritic and other schists, and in some igneous rocks. Sometimes it is found in iron-ore beds; is also found in alluvial deposits associated with precious stones and gold.	Becomes colorless upon heating. In powder is decomposed when fused with soda on platinum wire.

CHARACTERS.

TREATMENT WITH ACIDS, ETC.

	COLOR.	LUSTRE.	STREAK	FUSI- BILITY.	HARD- NESS.	SP. GR.	CRYs- TALLI- ZATION.	MAGNETIC BEFORE OR AFTER HEATING.	USES.
Heated in closed tube blackens, but resumes its original color on cooling. Soluble in acids without effervescence.	Deep red to orange-yellow.	Subadaman-	Orange yellow.	Infus.	4-4.5	5.6	III.		See under heading ZINC, etc.

mined in New Jersey for the extraction of this metal. Occurs with willemite and zincite at Sterling remaining after the extraction of the zinc, being treated as a manganese ore and sold to the

See under heading ZINC, etc.

Fused with soda, and the fusion dissolved in HCl, the dilute acid solution turns turmeric paper orange-yellow (zirconia). Not acted upon by acids except in fine powder with concentrated sulphuric acid

Red, brown, Ada-
yellow,
green, or man-
gray; pale tine.
yellowish
to
colorless.

Un-
col-
ored.
Infus.

7.5

4.5

II.

Used to a small extent in
jewelling watches.

II.—CLASSIFICATION OF MINERALS.

(AFTER BRUSH.)

MINERALS WITH METALLIC LUSTRE.

A.—Fusible from 1-5, or easily volatile :—Native antimony—stibnite—native arsenic—arsenopyrite—bismuth—bismuth glance—tetradyomite—wittichite—smaltite—cobalt glance—linnaite—native copper—copper pyrites—chalcocite—bornite—tetrahedrite—native gold—sylvanite—nagyagite—magnetite—hematite (specular iron)—iron pyrites—marcasite—pyrrhotite—galena—native mercury—cinnabar—niccolite—pentlandite—millerite—ulmannite—gersdorffite—platinum—silver—argentite—stephanite—dyscrasite—miargyrite—polybasite—freieslebenite—stromeyerite—stannite—wolframite.

B.—Infusible or fusible above 5, and non-volatile :—Chromite—graphite—iridosmine—magnetite—hematite (specular iron)—turgite—limonite—ilmenite—franklinite—pyrolusite—psilomelane—braunite—manganite—hausmannite—molybdenite.

MINERALS WITHOUT METALLIC LUSTRE.

A.—Easily volatile, or combustible B. B.:—Valentinite—kermesite—orpiment—realgar—cinnabar—calomel—sulphur.

B.—Fusible 1-5, and non-volatile, or only partially volatile. (I) Those which yield a metal or magnetic mass with soda :—Bismutite—crocoite—cobalt bloom—malachite—azurite—atacamite—cuprite—almandite—iron lime garnet—hematite—siderite—cerussite—rhodonite—wulfenite—annabergite—pyrargyrite—proustite—cerargyrite—embolite—bromyrite—iodyrite—wolframite—hubnerite.

(II) Those which do not yield a metal or magnetic mass with soda :—*Cryolite—potash alum (kalinite)—apatite— asbestos (amianthus, actinolite)—barite—borax—gypsum—epidote—orthoclase—oligoclase—albite—fluor-spar—halite—hornblende (amphibole)—rhodonite—nitre (common saltpetre, Chile saltpetre)—obsidian—pyroxene—scheelite—wollastonite.*

C.—Infusible, or fusible above 5 :—*Bauxite—cervantite—apatite—asbestos (chrysotile or bostonite)—calcite (limestone)—dolomite—asbolite—chrysocolla—corundum—diamond—emerald—fire-clay—chromegarnet—turgite—limonite—bog iron ore—siderite—ankerite—kaolinite—chlorite—serpentine—talc—magnesite—wad—rhodochrosite—mica (muscovite)—monazite—genthite—zirconite—opal—hypersthene—ruby—rutile—sapphire—quarts—cassiterite—scheelite—turquois—sphalerite—smithsonite—sinc-bloom—calamine—willemite—zincite—zircon.*

Hydrocarbons :—*Anthracite—bituminous coal—lignite—asphalt.*

III.—APPENDIX.

TEST FOR ALL CARBONATES (Calcite, Dolomite, Malachite, Siderite, Cerussite, etc.).

Make a bead of *salt of phosphorus*, and heat in O. F. until all bubbles are out. Then take up a minute fragment of the mineral to be tested in the bead and heat in O. F. If the fragment gives off gas or effervesces in the bead, causing bubbling in the bead, it is a carbonate. The usual effervescence with hydrochloric and nitric acids is a further test.

TEST FOR SILICA AND SILICATES.

The substance to be tested is broken, and a fragment heated for three minutes in the O. F. in a bead of *salt of phosphorus*, as for carbonates. Silica and most silicates give a skeleton of undissolved silica, which remains in the bead. Metallic oxides and other salts are dissolved, leaving no skeleton. Some silicates do not give this reaction, but quartz always gives it.

TEST BY HEATING WITH COBALT NITRATE.

The mineral is ignited strongly in the O. F. and then moistened with a drop of cobalt nitrate and again ignited. The fragment may be supported on charcoal or in the platinum forceps.

ALUMINA gives a blue color (clay, etc., same).

MAGNESIA gives a pink color.

ZINC AND TIN (see description). The coating on charcoal produced by burning zinc when moistened with cobalt nitrate gives a yellow or dirty-green color. The coating on charcoal produced by burning tin when so moistened gives a bluish-green color.

SILICA gives a faint bluish color. Generally partially fused.

Note.—All minerals assuming a dark color on heating, or remaining dark on heating, cannot be used in this test.

TEST BY FLAME COLORS.

A long colorless O. F. is blown. A fragment of the substance is then approached to the flame (being held in platinum forceps). When it touches the flame just back of the inner blue point, the color imparted to the flame beyond this is to be noted.

CALCIUM gives a reddish-orange color (calcite, dolomite, etc.).

BARIUM gives a yellowish-green color (barite, witherite, psilomelane, etc.).

STRONTIUM gives a scarlet color (celestite, strontianite, etc.).

SODIUM gives an intense orange-yellow color (feldspar, Chile nitre, etc.).

POTASSIUM gives a violet or lavender color (feldspar, etc.; also common nitre).

LITHIUM (rare) gives a deep-red color, with tinge of purple (lepidolite, etc.).

A FEW SIMPLE TESTS.

A.—Lead. If the specimen is very heavy, and on cutting shows a surface having a grayish metallic appearance, it may be galena or lead sulphide. If it is heavy, with no metallic shine, and of a yellowish color, it may be carbonate of lead. In either case put a few drops of nitric acid on the rock, then after a minute as much water, and finally place a small piece of iodide of potash on the wet spot. If the rock turns a bright yellow, lead is present, etc.

B.—Copper. Specimens having a strong blue or green color, or with a gray metallic lustre, and hard to cut, should be tested for copper. Treat with nitric acid, as before; then add quite a little ammonia-water; if the sample turns a very deep blue, copper in some form is in the ore. (Do not confound with nickel.)

C.—Silver. For silver, grind a small fragment to a fine powder; put one half in a small bottle with a little strong ammonia-water; shake, cork, and let stand for some hours; pour off the solution, and add an equal quantity of nitric acid. If the liquid becomes milky, or a curdy mass forms in it, there is chloride of silver in the ore. The other half is to be heated in a test-tube with nitric acid, the solution poured off, and a grain or two of common table salt added. If a curdy mass forms which does not dissolve in boiling water (but does dissolve in ammonia) and turns dark on exposure to light, silver is present.

D.—Gold. Gold can be proven with certainty only by "panning" or assaying. (W. L. Brown.)

PROCESS OF ASSAYING FOR SILVER AND GOLD.

(A) *By the Scorification Method.*

In brief : Grind ore in mortar very fine, so that it will pass through an 80-mesh sieve, and weigh one tenth of an assay ton of it. Next weigh about one assay ton of test lead and divide in halves; put one half in a scorifier and mix with it the ore; place the other half on top, and add a piece of borax glass the size of a pea; heat in a furnace in a muffle till everything in the scorifier is melted and no vapors of lead arise from it. Take out, pour in an iron mould, break slag from button with a hammer, place button in a cupel in the muffle, and heat until the lead has been driven off; weigh in milligrammes bead left in cupel, which bead equals gold and silver. Place this bead in a test-tube and heat with nitric acid to dissolve the silver; pour off acid and wash with distilled water, take out the gold, dry and weigh; first weight less second, equals silver; each result multiplied by ten, equals the number of ounces troy per ton avoirdupois of the precious metal contained in the ore. Often advisable to unite a number of buttons when separating the gold from the silver.

(B) *By the Crucible Method.*

Used where the character of the ore is well known and flux prepared accordingly. Weigh one-half an assay ton of the pulverized ore, add requisite amount of flux (50 to 80 gms.), cover with borax glass, fuse in muffle from twenty to forty minutes, pour in mould, and proceed exactly as in the scorification method except as to multiplying the weights by two instead of by ten.

ASSAYS OF SILVER ORES.—B. B.

An amount equal to 100 mgm. of the ore is weighed out, and mixed with 500 mgm. test-lead, and one spoon (about 100 mgm.) borax glass, the mixing being done in the brass scoop. Make a cartridge of soda-paper (this is filter-paper soaked in soda solution and then dried), place the mixture in the cartridge, and fold up tight. Then put the cartridge in the charcoal crucible and heat in a good reducing flame until all the paper is charred. Keep covered by the reducing flame until all paper is burned and the lead is in one button and the slag in another. Then oxidize in O. F. until the lead button is yellowish on cooling, and red when hot. (As long as the sulphur remains in the button it will be dark gray or black on cooling, not yellow.) When the button is yellow when cool, pour out on the anvil, make a cupel, and heat it to expel moisture; then place the button on the cupel and heat until it has been reduced to one-tenth inch in diameter. Allow the litharge formed to collect around the button; conduct this part

of the operation at a low temperature. Now make another cupel; prepare the surface by oxidizing a little test-lead and driving the oxide into the cupel; place the button broken from the former cupel on this newly-prepared one and complete the cupellation. In this last operation direct the flame (hot O. F.) at the cupel around the button rather than at the button itself, and do not allow the bottom of the cupel to become "wet," i.e., keep all the litharge soaked up by the cupel. As the button nears the glance, white specks appear on its surface, then a play of prismatic colors, then for a moment it is dull, and suddenly it breaks out in a bright glow, which almost immediately fades. This last is the glance; when it fades the cupellation is complete; stop blowing. Weigh in mgms.; this gives percentage, 1 per cent, or each milligramme = 291.66 oz. per ton.

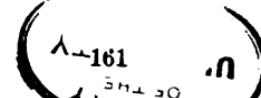
In case of poor ores cupel several portions of 100 mgm. down to one-tenth inch as above, and then unite these buttons and cupel to a finish. The final button may be weighed, or if less than 1 mgm. it may be measured on the Plattner scale, and the weight thus ascertained.

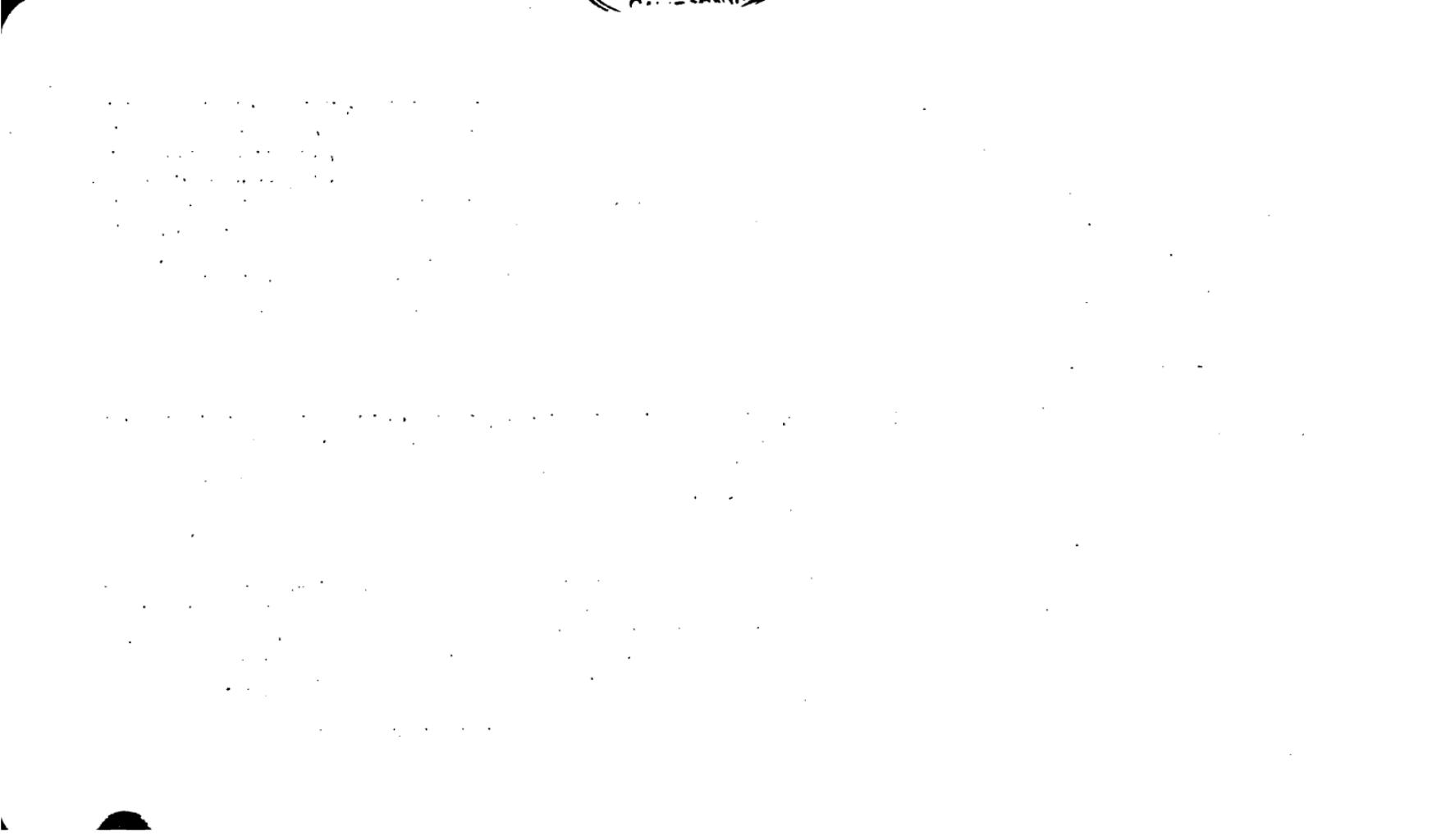
ASSAYS OF MERCURY ORES.

Mix 500-1000 mgms. in fine powder with 5-10 gms. litharge and introduce into a tube, bent with an elbow. This glass tube is one-fifth inch in diameter and seven to eight inches long. Heat until the assay is fused and the glass becomes attacked. Mercury collects beyond the elbow in drops; condense the deposits there by careful heating; break the tube and weigh portion with mercury. Then clean out mercury and weigh again; difference is mercury; 0.05 per cent may be thus estimated.

TO OBTAIN PERCENTAGE OF A GIVEN ELEMENT IN AN ORE.

To get the percentage of any element in a given ore or compound is simply a matter of proportion—e.g., Magnetic Iron Ore (Fe_3O_4). First refer to tables of atomic weights, and we find the atomic weight of iron (Fe) to be 56, which multiplied by 3 gives 168; while the atomic weight of oxygen (O) is 16, which multiplied by 4 gives 64. These added ($168 + 64$) give 232. Now make the proportion $232 : 100 :: 168 : x$, and it is found that 72.4 is the percentage of metallic iron. In the same way the percentage of oxygen is found to be 27.5. The method shown in the above example gives the *possible* percentage in any ore or compound according to the chemical formulae given in the "Tables." Such purity as is indicated by the formulae is, however, very rarely and in many cases never met with. It follows, of course, that the percentage of the desirable element in the ore is reduced in proportion to the impurities present.





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